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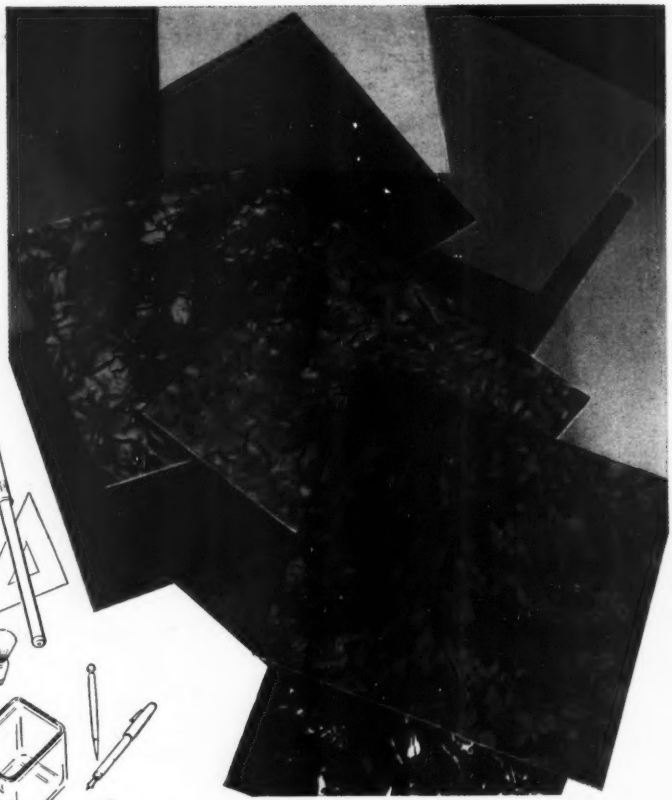

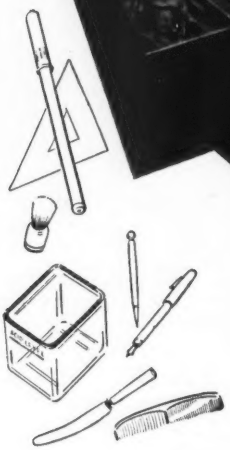

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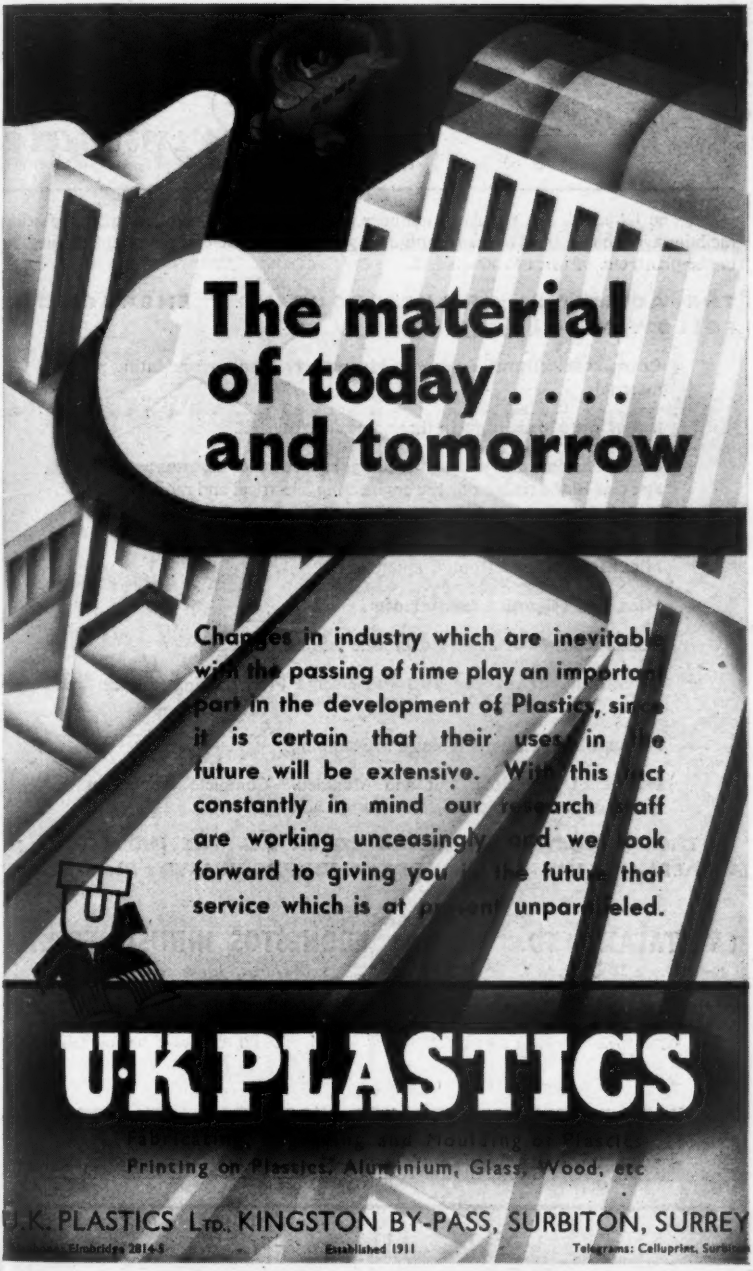
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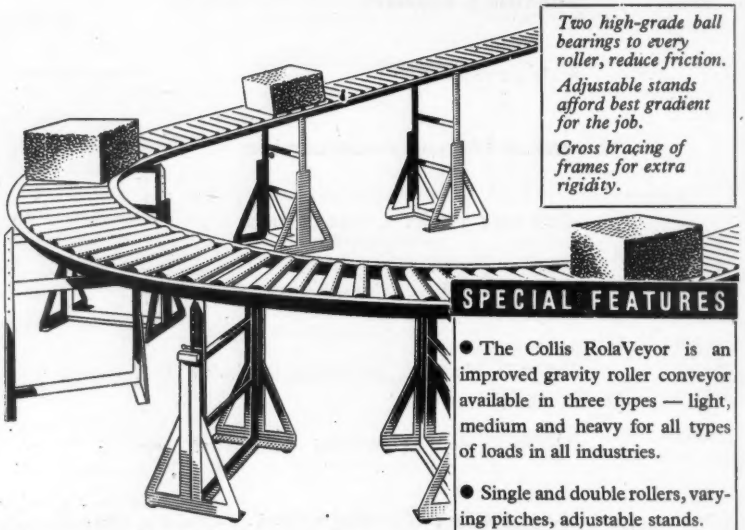

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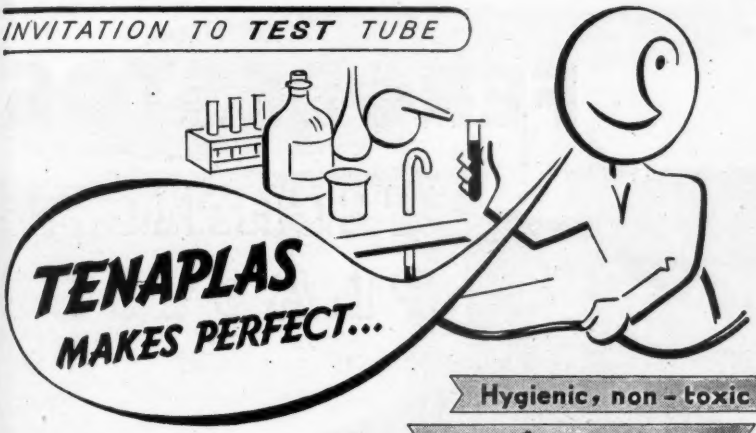

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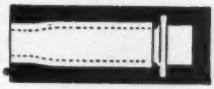

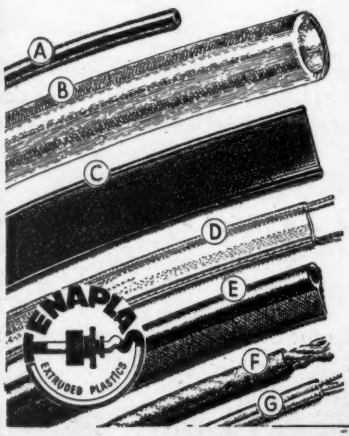

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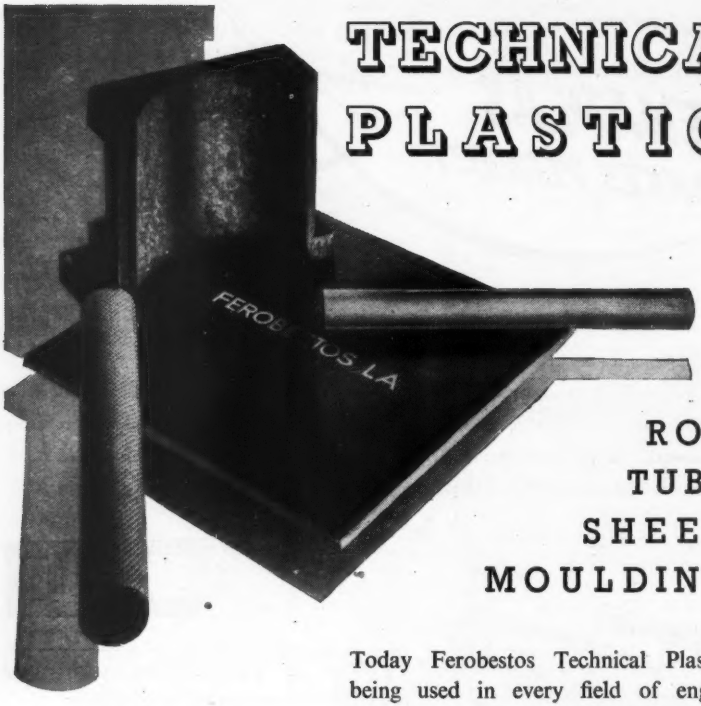

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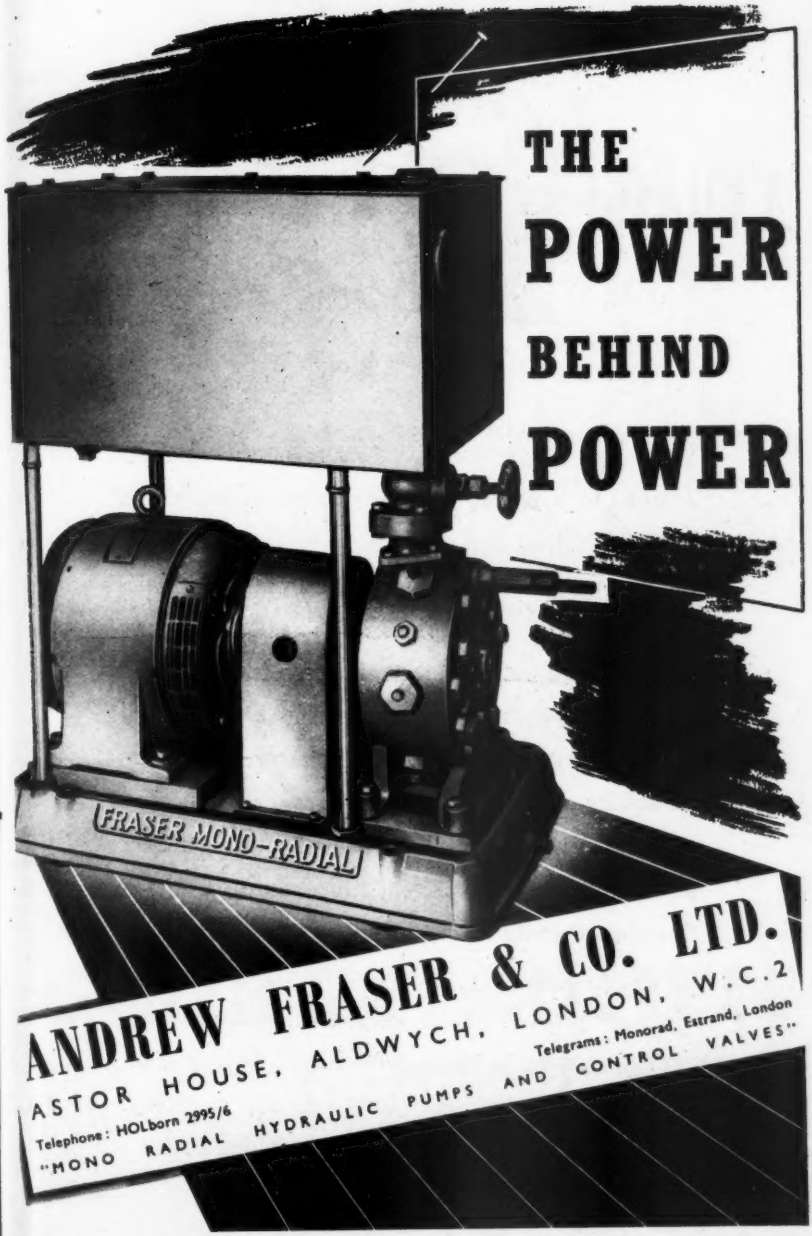
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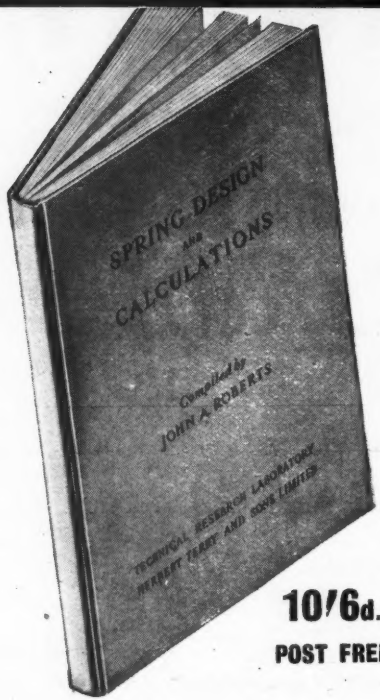

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List of contents

Foreword

1 *Helical Compression and Extension Springs*
2 *Extension Springs and Initial Tension*
3 *Calculation of Helical Compression and Extension Springs*
4 *Square and Rectangular Section Springs*
5 *Volute Springs*
6 *Conical Springs*
7 *Valve Springs*
8 *Surging of Valve Springs*
9 *Natural Frequency*
10 *Natural Frequency of a Single Mass System*
11 *Springs with Material Subject to Bending Stresses. (Helical and Spiral Torsion Springs)*
12 *Power of Clock Type Springs*
13 *Flat Springs*
14 *Multiple Leaf Springs or Laminated Springs*
15 *Belleville Washers*
16 *Circlips or Retaining Rings*
17 *Combined Axial and Horizontal Loading on Compression Springs*
18 *Spring Driving Belts*

Tables

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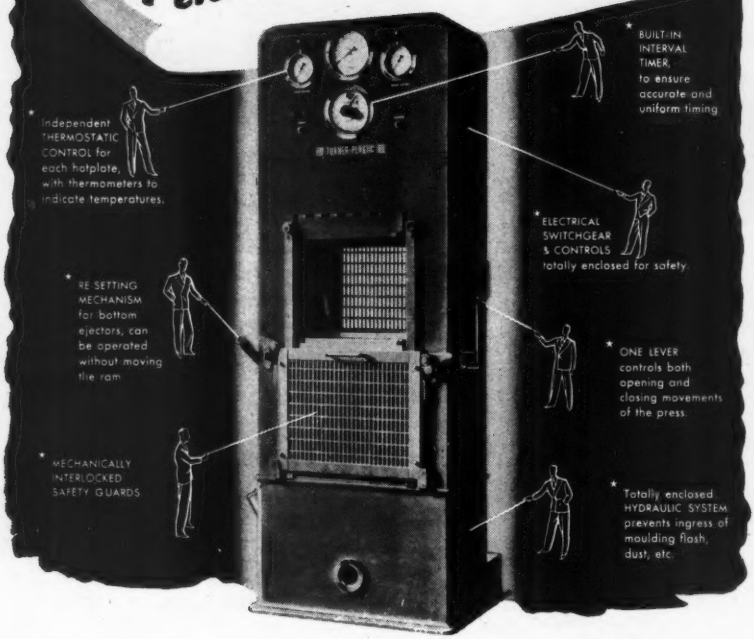
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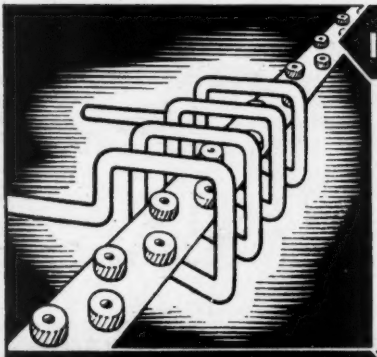

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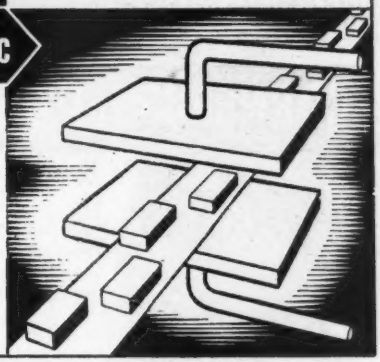

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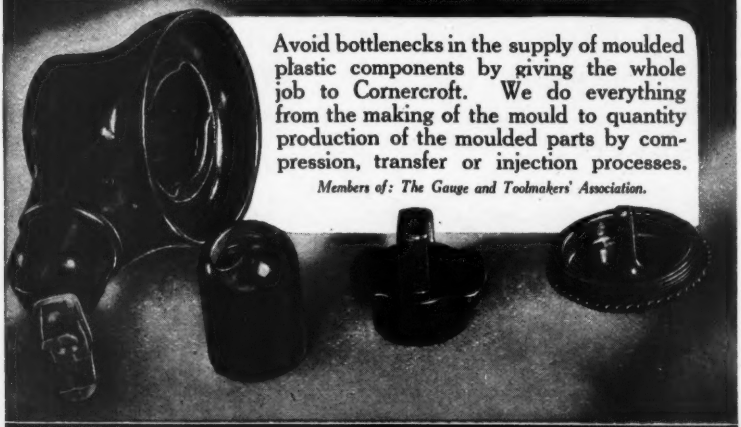

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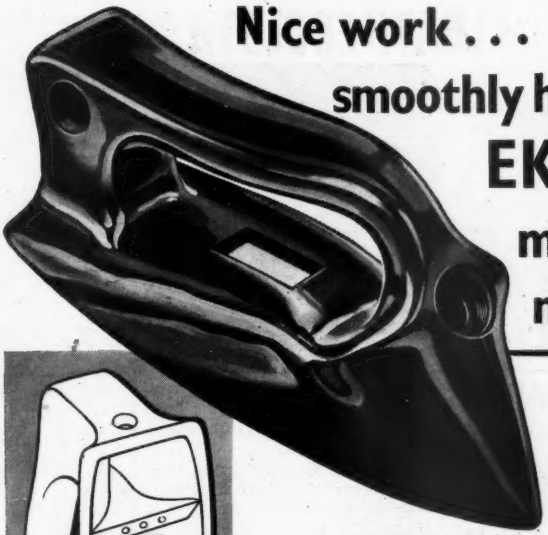

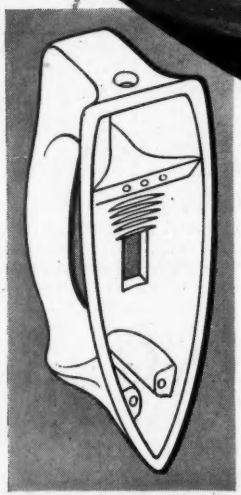

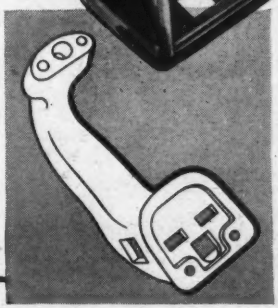

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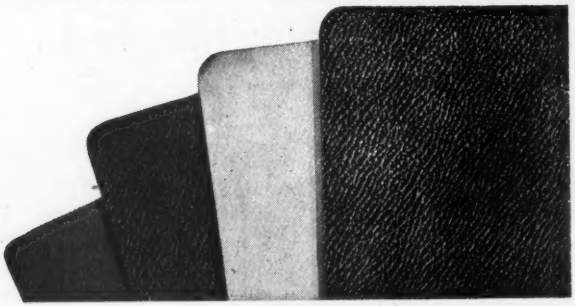

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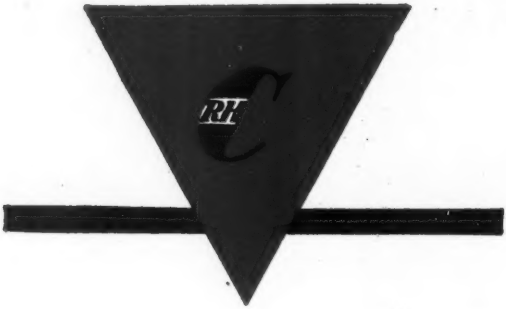

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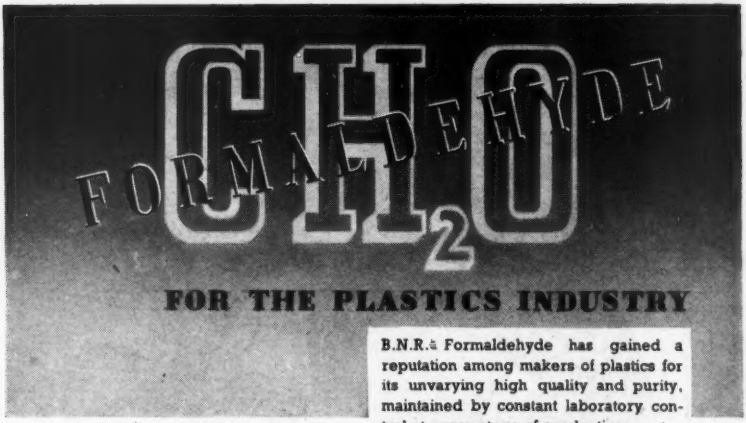

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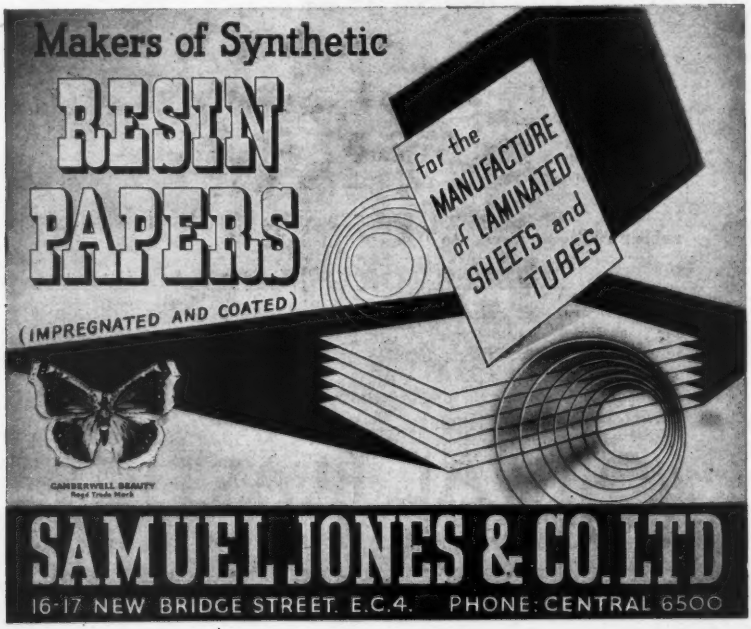
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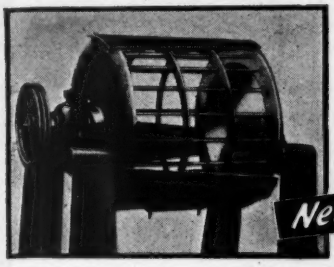

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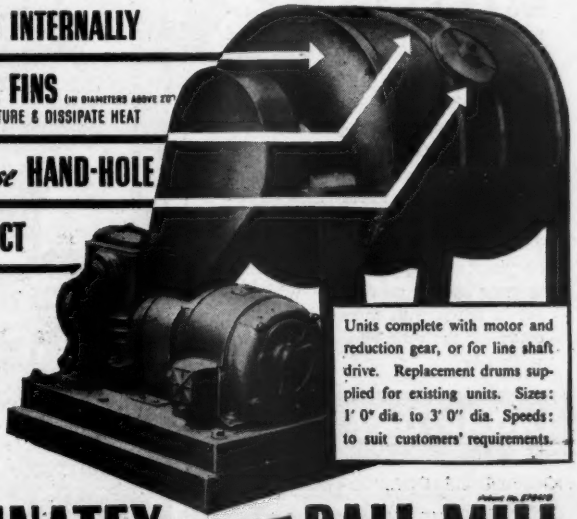

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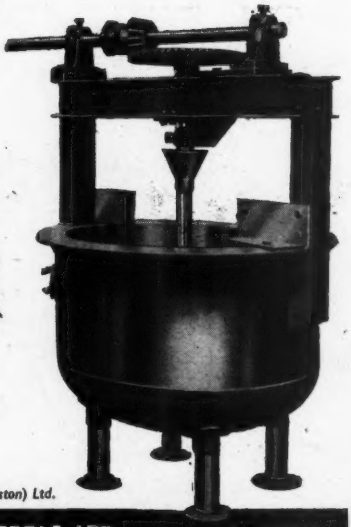

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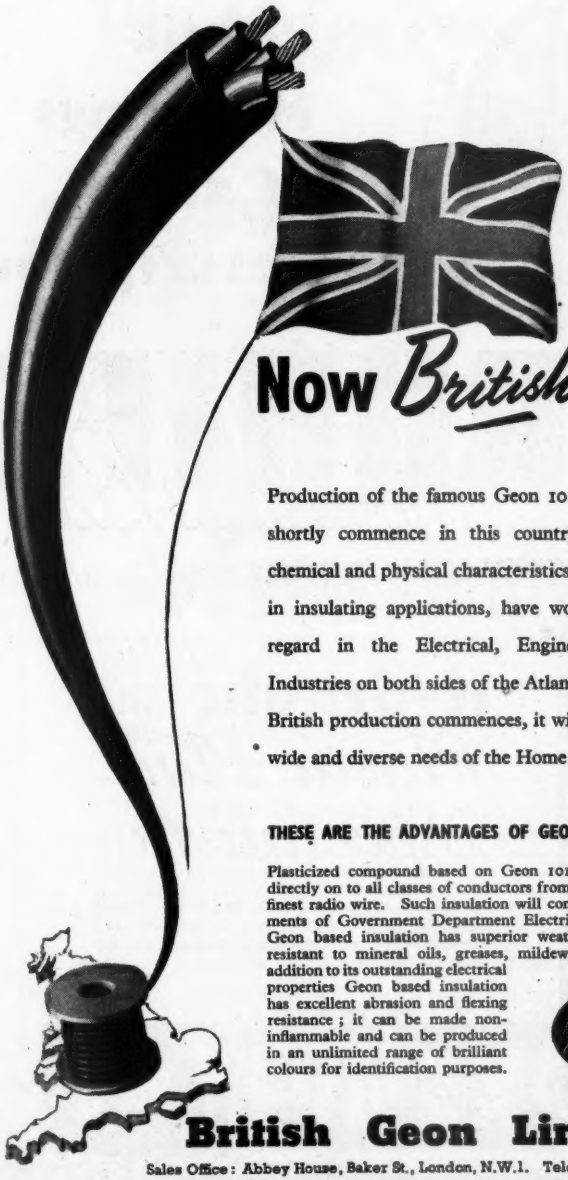

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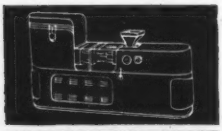
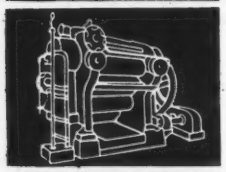
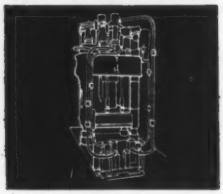

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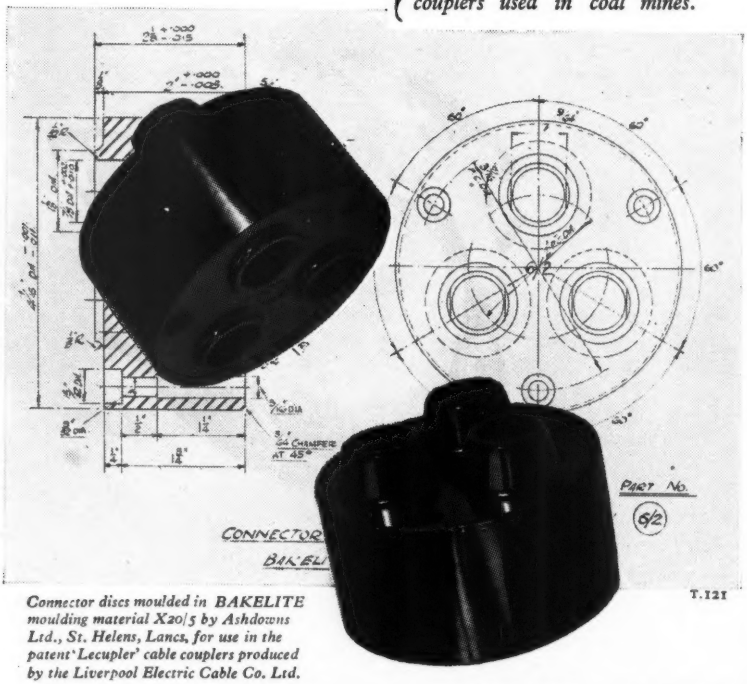

Connector discs moulded in BAKELITE moulding material X20/5 by Ashdowns Ltd., St. Helens, Lancs, for use in the patent 'Lecupler' cable couplers produced by the Liverpool Electric Cable Co. Ltd.

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Vol. XI. No. 125 OCTOBER, 1947

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
Managing Director - ROLAND E. DANGERFIELD

Editor - - M. D. CURWEN, B.Sc., A.R.I.C.
Offices - Bowling Green Lane, London, E.C.1

CONTENTS

	Page
Editorial	508
The Spraying of Plastics ..	511
Lubrication of Plastic Bonded Fabric Bearings, by A. H. Stuart	516
Laminated Material in Unusual Applications ..	521
Book Reviews	522
World's Industry Employs Plastics	523
Inflated Toys for the Beach	525
Cellulose Acetate Plastics, by Vivian Stannett ..	526
Modernized Interior for Indian Railway Coaches	532
Furfural and its Derivatives, by H. Ronald Fleck ..	534
Acetylated Cotton as Filler for Phenolic Moulding Powders, by E. E. Halls ..	541
Plastics at Hanover Trade Fair	545
Letters	547
Production News	549
New Productions from the Moulding Shops	551
Patent Review	553
Microscopic Examination of Plastic Materials, by J. H. Wredden	557

NOTICES

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EDITORIALS

Publicity and Plastics

WE have received a letter from Duratube and Wire, Ltd., congratulating us on our editorial, "Quality Goods," published in the September issue of this journal, at the same time calling for a widespread publicity campaign for clarity and accuracy in the nomenclature of plastics. The managing director of the above-named company has already drawn attention, in two excellent articles published in "Overseas and Transatlantic Mail" and "The Ambassador," to the misleading and even dangerous use of expressions such as elastic-glass, plastic-glass, plastic-leather, plastic-silk, and so on. The plastic referred to in this instance is polyvinyl chloride, which name we usually shorten to p.v.c.

How we detest such stupid expressions, which are so obviously the progeny of the completely uninformed or of those deliberately employing such forms to stagger the poor public with the so-called wonders of science! In other words, they are the work of the charlatans of publicity, and it may well be that we will get our surest aid from responsible authority within that important sphere of industrial activity, once it realizes how misleading such expressions are. On the other hand, we must be ready with alternative descriptions, and here we face a very thorny problem, especially when we have to deal with the public—the non-technical man- and woman-in-the-street.

Are we to talk of any plastic whatsoever, thermo-hardening or thermoplastic, simply as "plastic" or are we to differentiate, and how far? So far as the technical world outside our own is concerned, there is little difficulty, and our greatest customers, such as the electrical, chemical and engineering worlds, know as much as, and sometimes more than, we do ourselves about the individual materials we produce—at least so far as their properties and their employment are concerned. Propaganda to the public is a very different pair of shoes.

It has been suggested (to take one plastic only as an example) that we refer not to plastic curtains or plastic belts or plastic raincoats, but to p.v.c. curtains, p.v.c. belts, and so on. Our own private objection to such a system is at least threefold. The public cannot possibly have any idea what p.v.c. means, and may consider the letters a trade mark and not a raw material. We have a horror of the general use of initials, an appalling form sprung on the modern world by nations or organizations devoid of tradition. Lastly, not only is p.v.c. a mixture of substances and the pure substance, and articles made from it can be quite hard and thus different from what we normally call p.v.c., but other newer yet similar compounds, cross-polymers and so on, are being, and will be, produced. They are used for exactly the same purposes and look the same. The public would certainly never detect the difference.

Our own method of approach to the whole subject would be to improve the quality of all plastic goods made and to describe them simply as made from plastics. This would create in the mind of the public the most important of all objects, the realization that a new series of valuable raw materials has been created. At the same time there should be a co-ordinated endeavour to teach the public something about them, about their differences and their resemblances, and about the immense variety of their forms. Good work has already been done by private concerns, but the effort must be intensified. As a first step we must teach the teachers, by whom we mean the propagandists and the publicity and advertising agents. This done, we may then begin to differentiate.

Passing Events

WITH a mayoral blessing, two events of interest to the plastics industry took place on the same day during September. To be more precise, on the 17th of last month the Mayor of Tynemouth officially opened the new plastics factory of De La Rue Insulation, Ltd., at the West Chirton Trading Estate, North Shields, and almost simultaneously the Lord Mayor of Birmingham was opening a new plastics laboratory at the Nelson Street Schools, Birmingham, which are under the direction of the Central Technical College in that centre of industry.

But for circumstances connected with the present economic situation there would have been a greater gathering to witness the Mayor of Tynemouth press a button which set in motion the largest of the presses at the new works; the ceremony, however, had to be informal, in keeping with the austerity in so many other things which we suffer. It is at these works that plastic laminated boards of the type for some time past manufactured in America under the name of "Formica" are now to be made in this country by arrangement with the Formica Insulation Co., of Cincinnati. The factory has been in production on a limited scale for some months, but full capacity is expected to be reached early in 1948, when employment will be provided for over 1,000 workers. It is understood that a large proportion of the output in the immediate future will be earmarked for export.

The plastics laboratory in Birmingham is the first of its kind in the Midlands, and the scheme of the Education Department in providing for it has received the whole-hearted approval of the plastics industry there. Training in the technology of plastics under the direction of the Central Technical College has hitherto been upon a small scale—indeed, it has been in quite a minor way—but with these new facilities an effort will be made to cover the whole field. With the opening of the winter session close on 70 students are being part-time released from employment in various plastics undertakings in the Birmingham area to undergo more specialized training, with courses of instruction having the full approval of the Plastics Institute.

Courses leading to the City and Guilds diploma in the technology of plastics were inaugurated at the Central Technical College in 1937. This was, we believe, the first stage in the development of local educational facilities for plastics, and was parallel with developments which were taking place in centres outside Birmingham. On the outbreak of the war, the courses in Birmingham were suspended, but, in 1943, there was raised the question of reviving them and of extending such facilities on a scale to be in keeping with the importance of the city as a centre of the plastics industry.

There is little to add, apart from wishing the new laboratory the best of achievements in a great industrial city where there has been no specialized institutional training in plastics since 1939, when the plastics industry was so very different from what it is at the present day. We would also like to endorse the remarks of Mr. J. Wilson, principal of the Central Technical College, at the luncheon which preceded the opening ceremony: "In any scheme of training in which industry and education takes part jointly, one of the main purposes must be to train personnel and fit them into industry where they are needed and where they will be qualified to do their job well."

Metal Shortage

THAT there is a serious shortage of metal in the world is no news, but a recent statement that there is a real dearth of certain metals in the crust of the earth *is* news.

During the 1914-18 war an American statesman declared that the copper, lead and zinc mines of the world were being rapidly depleted because of the appalling wastage of these metals in war-time. The mind boggles at the rate of expenditure of metal in the 1939-45 war, which was carried out on such a vastly increased

scale. The steady increase in price that has taken place since 1914, whilst indicative of the demand, also reflects the true state of affairs.

It is true that we have plenty of iron and an inexhaustible supply of aluminium. Much useful research on the use of the latter in the form of conducting wire for electricity, for example, has been carried out and some countries are already so using it. No doubt aluminium and that other light metal, magnesium, also in inexhaustible supply, will find still wider uses.

Contemporaneously the use of plastics has expanded in quite legitimate ways in the replacement of metal, although most of the replacement refers to steel and tin. Is it not time that an economic survey of our metal resources was made and our plastic products planned and geared up to such a survey, and to our coal and petroleum production? There is clearly a need for it.

Happily, there is always in such times of shortage a search for alternatives quite irrespective of collective effort. Thus already in the printing industry, which uses such enormous quantities of high quality copper and zinc in the manufacture of printing blocks, we see the gradual adoption of plastics instead—and very successfully, too—on a big scale in the U.S.A., on a lesser scale here.

There is little doubt that plasticized polyvinyl chloride is a suitable replacement for lead piping for the home and the works, resulting, moreover, in an " unburstable " pipe in cold weather. It is only the present shortage that puts the brake on such a development.

There is also little doubt that the hard, pure polyvinyl chloride is a suitable replacement for lead roofing and guttering, while we have already given examples of copper units such as cistern floats, which can be and are being made of plastics.

As for the chemical industry, where the use of copper, lead and other special metals is high because of corrosion, the need of replacements is exceptionally important. At high temperatures metals cannot be replaced by plastics. At medium temperatures, phenolic types in the form of tanks, pipes, pumps, valves, etc. have proved themselves during the past 20 years. More recently, the ability to weld thermoplastic materials has resulted in the production of a wide range of important units for the chemical industry, although restricted to normal temperature work. Tanks, pumps, condensing plant, piping, funnels, acid or acid-salt containers, fume cupboards and ducts, and a host of other units are practical and wholly economical.

Contemporaneously, we have now also the technique of spraying plastics on metal or other non-corrosion-resisting materials to produce corrosion-resisting structures. By this technique almost any plastic, thermosetting or thermoplastic, can be applied so that a fairly wide range of temperature can be satisfied. This method has its own problems; for example, the differences in coefficients of expansion of plastics and the base on which they are sprayed must be taken into account.

The future is, therefore, by no means gloomy. It seems that human ingenuity is always ready and able to find a way to cure human stupidity and human wastages.

CERTIFICATES TO CRAFTSMEN

Following the widespread adoption of the model indenture prepared by the Education and Apprenticeship Committee of the Gauge and Tool Makers' Association, the Council has decided to award under certain conditions a special certificate to craftsmen in the precision gauge and tool industry. This certificate will bear the Association's seal and the signatures of officers. Applications for award of the certificate will be considered from toolmakers who (a) have served a bona fide apprenticeship with a member of the Association, (b) have passed the final examination of the City and Guilds Machinists', Turners' and Fitters' Course. Further particulars are available on application to the Secretary, Gauge and Tool Makers' Association, Standbrook House, Old Bond Street, London, W.1.

The Spraying of Plastics

Fig. 1.—"Astral" suitcase Schori sprayed with external coat of polythene (Heston Aircraft Co., Ltd.).

OF all industries, that which produces chemicals and products made from them has its exceptional problems of corrosion; problems which, while no longer the nightmare of managers of such works, are still their urgent daily preoccupation—so great is the effect of corrosion on the general economics of production.

We have travelled a long way from the chemical industries of the 18th and 19th centuries, when glass, earthenware, certain woods, copper, lead and platinum were almost the only possible materials available for the construction of chemical plant. These, with the exception of platinum, are still widely used, but with the 1900's other metals such as silicon-irons and aluminium, and newer materials such as fused silica, were adopted as alternatives of structure for plant to be used in the manufacture of products for the expanding chemical and allied industries. In the 1920's stainless steel appeared, and somewhere about 1925 storage tanks made of synthetic resin were first employed.

To counteract the high cost of structures of solid costly metal, it was in the 1910's that attempts were first made to replace them with something cheaper, such as iron and steel lined or protected at strategic points with organic materials that are resistant to chemicals. Foremost among these came rubber (which is very resistant to hydrochloric acid) applied in the form of sheet, suitably cemented. More recently, polyvinyl chloride sheet has been similarly applied. Obviously the use of such organic linings was limited to low-temperature work, but with much need for the transport and storage of corrosive chemicals such applications have become common.

In 1925 research was being carried out on a new process of producing acid-resisting coatings upon iron and steel by depositing thereon a relatively thin film of some other metal offering a better degree of resistance to corrosion by chemicals. This was the well-known process of metal spraying, making use of a special "pistol" to which was fed metal in wire, ribbon or powder form, there to be vaporized by passage through a heated atmosphere. To-day, almost any metal except those of extremely high melting point can be deposited on metal, wood, or other bases.

To complete the cycle of events, the same method is now applied to the production of organic films or coatings, and we have arrived at a stage where almost any organic material that can be produced in powder form and capable of softening or flowing under heat can be applied by the spray process to the surface of rigid structural materials.

Synthetic resins of all types come into

Fig. 2.—Fuel tank of flame-thrower for army use, sprayed externally with polythene.

this category and both those of the thermosetting type, such as the phenolic resins, and those of the thermoplastic type, such as polyvinyl chloride and polythene, have begun to assume wider industrial importance for application by the new process.

Schoop, of Zurich, began experiments in flame spraying, somewhere about 1911; he employed metal wire for feeding the pistol and generally experienced difficulties in the use of metal powders. Schori, also working in Switzerland, in the early 1920's, was the first person successfully to employ powders in flame spraying. The pistol which he developed is substantially the same form as that now used by Schori Metallising Processes, Ltd., at whose works in London we recently, for the first time, had the spraying of plastics demonstrated to us.

The materials capable of being used include almost any plastics excepting those with a melting point higher than 400 degrees C. Even certain thermosetting resins of the PF and UF type and ebonite are adaptable, but the greatest success as yet has been achieved with polythene. In view of the difference in coefficients of expansion for polythene and the metal base, however, it appeared to us that perfect adhesion against the conditions likely to arise in actual service might be largely a matter of skill for the operator engaged in flame spraying, as also possibly in the preparation of the surface to be sprayed, yet by what we saw we were notably impressed, especially after examining the aluminium suitcases with an external coating of polythene (Fig. 1), which are already in production. Still further proof of the efficiency of the process was forthcoming from flame-thrower fuel tanks (Fig. 2), which had to stand up against exceptionally drastic conditions in military usage.

Considerable experimental work in the flame spraying of non-metallic coatings was done between 1935 and 1940, since when it has become evident that applications in the plastics field are likely to become comparable with, or even exceed,

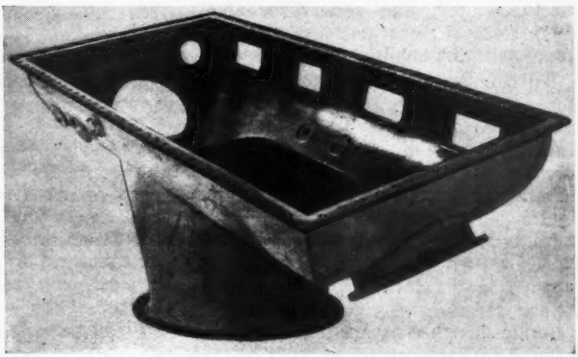


Fig. 3.—Welded steel condenser coated internally with Thiokol, $\frac{1}{8}$ inch thick, to resist corrosion.

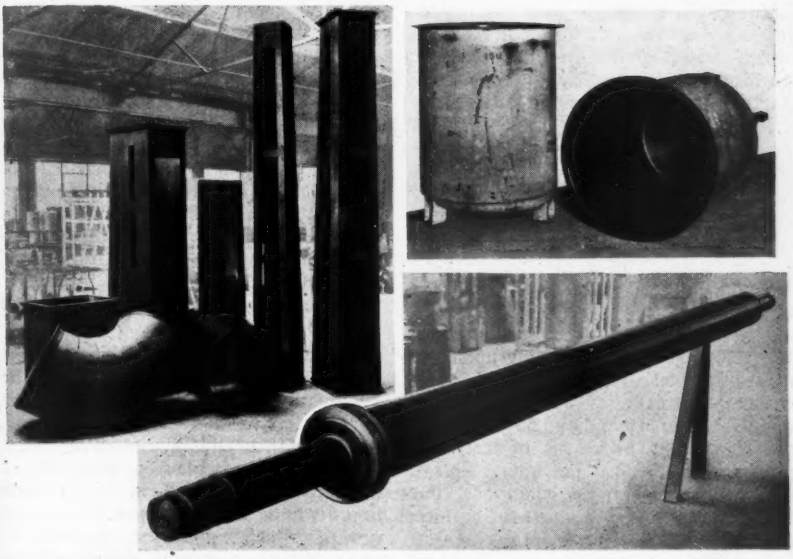


Fig. 4.—Examples of the application of sprayed polythene for industrial plant. (Left) Ducting for conveying acid fumes. (Top right) Tanks for chemical plant. (Foreground) Polythene-sprayed steel roller for paper mill machinery, to replace similar roller made of stainless steel.

applications in the spraying of metals. The earliest non-metallic material used was bitumen, which could be applied in thicknesses up to $\frac{3}{8}$ inch with one pass of the flame spraying pistol.

Closely following bitumen came coatings of one of the synthetic rubbers—Thiokol, a material which received considerable development in America and during the war found considerable use in England as a sprayed coating for condensers in marine engineering. Marine condensers (Fig. 3) coated on the inside with $\frac{1}{8}$ inch of Thiokol (which, chemically, is one of the polysulphides) proved to be capable of successfully standing up against very difficult corrosive conditions, and were considerably less costly than the solid bronze parts hitherto employed. Thiokol coatings, likewise, are applicable to the sheet metal ducts used in air conditioning systems, and for the impellers and castings of fans employed in moving air laden with acid fumes. For fans there appears a particular advantage, in that the Thiokol coating does not slip under centrifugal force, as it does in cases where rubber sheeting has been applied with adhesives.

The Schori flame spraying pistol (Fig. 6) has no moving parts. From the annular compound nozzle a flame of burning gases, some 2 inches long, emerges. The gases commonly used are oxygen with acetylene or propane or enriched coal gas, both controlled by needle valves and mixed by an injector. The pistol is also fed with compressed air, the supply of which is controlled by a hand valve. In the head of the pistol the air splits into two streams; one half emerges from an annular nozzle which is outside the flame nozzle, the other half goes to the rear of the pistol, then passes through an injector, thence through a tube situated axially in the body of the pistol, and finally emerges

inside the flame. In passing through the injector the stream of air creates suction which draws up the metallic or plastic powder from its container so long as the operator keeps his thumb on a small hole at the back of the pistol. The flow of powder is under the control of the operator independently of the combustion of the gases.

The purpose of the outer annular air stream is partly to cool and protect the nozzle, partly to chill the sprayed material, and partly to direct and confine the flow of powder. The compressed air is supplied at pressures ranging from 10 to 60 lb./sq. in., depending upon the type of material being sprayed. Air consumption is about 12 cu. ft. per minute; gas consumption, 50 cu. ft. of oxygen with 40 to 45 cu. ft. of acetylene, propane, or other gas per hour. Spraying metal under these conditions, the operator can coat 250 sq. ft. of surface per hour.

The temperature reached by the particles in passing through the flame of the Schori pistol is controlled by varying the air pressure. The highest air pressures are used for material having a very low melting point (such as zinc or polythene), the lowest air pressures for metals with high melting points. Almost any metal with a melting point lower than 1,600 degrees C. can be sprayed satisfactorily.

In the case of plastics, almost the whole of the powder is fused in passing through the flame; it remains in the molten condition until it touches the surface which is being sprayed, and there it coalesces. This is rather distinct from the case of metal powder, where it is fairly certain that the particles are not wholly in molten condition and that the formation of the coating takes place by a process akin to sintering or welding, which is the basis of powder metallurgy.

The flame spraying process appears to be the only method by which either thin or thick coatings of polythene can be applied in a satisfactory manner to a metal base. The spraying of polythene was first developed for the protection of chemical plant against the action of alkalis; almost simultaneously there were interesting applications in the camouflage covering of field equipment for the Army. In the latter case the coatings had to satisfy several conditions. They had to be of suitable colour (olive green or drab), and of a texture that did not reflect light; likewise outstandingly tough and resilient, and of such good adhesion that they could resist the rough treatment which might be expected in service. Rigorous field tests showed that polythene in this connection was much superior to other plastics.

From experience gained in wartime uses, came new applications such as the polythene sprayed aluminium suitcases which have already been mentioned. Suitably filled, and pigmented in pastel shades, as well as black or dark blue, a thick coating of polythene with a matt finish is quite attractive apart from other qualities which it possesses. Applications in the covering of metal furniture offer notable possibilities. Smooth coatings, suitably pigmented, can be made with a remarkably close imitation of leather; they appear to withstand much rough usage without risk of revealing the underlying metal base.

The polythene spraying of jigs and suspenders for use in the electroplating industry is another interesting development. Here polythene has outstanding advantage over coatings hitherto employed, some of which break down electrically, with the result that the jig (as well as the articles for plating) gets a deposit of metal upon it, thus causing a rather serious loss of metal from the plating bath. With polythene-sprayed jigs the coating shows no deposition of metal; neither does it exhibit any tendency to entrap solutions and so carry them from one bath to another thus upsetting the delicate balance which is so desirable in modern electroplating practice.

Attracted by the success achieved in the flame spraying of polythene, we understand that certain manufacturers of plastic raw materials are giving attention

to the development of plastics suited to this process; among products under investigation are some of the acrylic resins, polyvinyl acetate, and resins of the melamine type. So far, however, among plastics proper we have personally examined and witnessed the spraying of polythene coatings alone.

In this spraying process it has already been hinted that great attention has to be paid to the preparation of the metal surface which is to receive its coating of polythene, or of Thiokol. The surface must be clean and free from greases; in certain cases a degreasing operation may be considered necessary, but wherever possible it is preferable to make use of shot-blasting to give a clean and slightly roughened surface.

For polythene, the standard Schori pistol will apply in one operation a coating of from 0.005 inch upwards, 0.015 inch being normal, and building up to ⅛ inch not uncommon. The polythene powder (grade 2C is standard) is prepared by a special process to a particle size within definite and fairly close limits imposed by its high viscosity in the molten state. The powder can be pigmented to give almost any colour, including delicate pastel shades, and special technique in spraying allows the production of a coating with crackled or wrinkled finish in place of the more usual smooth surface.

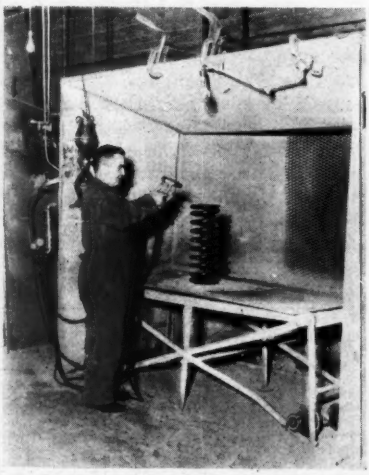


Fig. 5.—Flame spraying in progress for demonstration purposes at the works of Schori Metallising Processes Ltd.

Fig. 6.—The Schori spraying pistol: the sectional view shows the internal construction.

Flame spraying avoids the use of expensive solvents, with the necessity for recovering them and of giving protection against their hazards. Personal hazards in spraying are avoided by maintaining an adequate exhaust at the rear of the spraying booth.

German Plastic Literature, 1939-1943

Under the name "Fachkartei Kunststoffe," a new compilation by the editors of "Kunststoffe" has been published by C. Hanser Verlag, Munich 27. It consists of abstracts from the German and foreign technical literature in the plastics field. The present issue (pp. 75) covers the war years 1939-1943 and consists of about 150 abstracts, some illustrated by line diagrams. The fact that these abstracts are taken mainly from "Kunststoffe" does not detract from the value of this new compilation, as the issues of "Kunststoffe" which appeared during the war are difficult to obtain.

H

Lubrication of Plastic-bonded Fabric Bearings

By A. H. Stuart, Ph.D., B.Sc.

THE primary function of a lubricant in any bearing is to reduce the friction to a minimum. In a very large number of cases, however, there is the secondary function of avoiding an undue rise of temperature by conveying heat to a point where it can be conveniently dissipated. The heat which results from overcoming such friction as the lubricant is unable to eliminate is not usually large in amount and, in the case of metal bearings, the good thermal conductivity of metals in itself will often prevent the temperature rising to excess; but there are many cases in industry where heat from other sources operates on the bearings, and in such cases the problem of cooling assumes major importance. For rapid heat absorption by means of a liquid one naturally turns to water, because of its high specific heat (nearly twice that of lubricating oil) and of its high thermal conductivity (about four times that of oil).

Water, however, is a very poor lubricant in the normal type of metal bearing, but it offers good lubricating properties to the surface of certain resins used in plastics. In a number of cases, therefore, in which heat has proved a difficult problem, attention has been turned to the use of moulded plastic bearings, which have not only eliminated the troubles arising out of the use of oil-lubricated metal bearings, but have offered special advantages of their own. These bearings are of four main types:—

(1) Those fabricated from moulding powders, sometimes used plain but occasionally incorporated with a little finely divided graphite to act as a lubricant.

(2) Those made from laminations of woven textile products, bonded with the resin and moulded under pressure.

(3) Those moulded from felted fibres which are not orientated, being impregnated with a bonding resin.

(4) Laminated paper, bonded with a resin, has also been used.

Bearings of the first type have proved to be too brittle for many purposes and there is a tendency to replace them by those of the third type. Their use is largely confined to small units, such as the spindles of textile machinery. The most important type of bearing in the plastic range is that in which laminations of woven textiles are bonded by a synthetic resin. In these the fabric used is generally a heavy square-woven duck, bonded by means of a synthetic resin of the phenol - formaldehyde type. Average values for some of the physical properties of these materials are set out in Table 1.

Principles of Lubrication

Before considering the results of the laboratory tests on these bearing materials, which are given below, it may be well to have before us the general behaviour of the metal bearings which these resin-bonded bearings have to replace. The normal conditions which prevail in a well-lubricated metal bearing are usually referred to as fluid-film lubrication. In this case the metal sur-

Table 1.

	Laminated Material	Material based on felt
Specfic gravity.. ..	1.4	1.4
Tensile strength.. ..	10,000	8,000 lb./sq. in.
Young's modulus ..	10^6	10^6 lb./sq. in.
Brinell hardness	40	35
Compressive strength :		
at right angles to laminae	42,000	25,000 lb./sq. in.
parallel to laminae ..	22,000	—
Thermal conductivity ..	0.17	0.28 kg cal./ metre/hour/ deg.C.

Table 2.—Measurements of Coefficient of Kinetic Friction under Boundary Conditions, using 3-ball steel slider and bases named.

Test No.	Base	Conditions and Lubricant (if any)	Temp.	Coefficient of Friction
1	Resin-bonded fabric	None	20°C	0.19
2	Resin-bonded fabric	Degreased, washed and dried	20°C	0.11
3	Cast iron	Degreased, washed and dried	20°C	0.21
4	Steel	Degreased, washed and dried	20°C	0.18
5	Resin-bonded fabric	Water	20°C	0.11
6	Resin-bonded fabric	1% solution of sodium oleate	20°C	0.105
7	Resin-bonded fabric	Compounded lubricating oil	20°C	0.125
8	Cast iron	Compounded lubricating oil	20°C	0.15
9	Steel	Compounded lubricating oil	20°C	0.16
10	Resin-bonded fabric	1% solution of sodium oleate plus colloidal graphite	20°C	0.095
11	Cast iron	Lubricating oil plus colloidal graphite	20°C	0.14
12	Steel	Lubricating oil plus colloidal graphite	20°C	0.15
13	Resin-bonded fabric	Dry film of colloidal graphite	20°C	0.10
14	Resin-bonded fabric	Dry film of colloidal graphite wetted with 1% sodium oleate	20°C	0.085
15	Cast iron	Film of colloidal graphite wetted with lubricating oil	20°C	0.096
16	Resin-bonded fabric	Dry film of colloidal graphite	60°C	0.10
17	Resin-bonded fabric	Dry film of colloidal graphite	60°C	0.085
13	Steel	Compounded lubricating oil	60°C	0.12

Similar tests were made using as a base specimens of resin-bonded laminated paper, but the results obtained followed so closely those given by the laminated fabric bases that it was not considered necessary to record them here.

faces are separated by a film of oil, and the relative motion of the two surfaces results in the oil clinging to both surfaces and sliding takes place within the oil film.

Assuming that there are no high spots on the bearing surfaces which penetrate the oil film, the only friction which has to be overcome is the resistance to shear of the oil film itself. This resistance to shear is a function of the viscosity of the oil at the working temperature of the bearing. All oils show a marked drop in their viscosity as the temperature rises, and if an error of judgment is made in the choice of an oil it may happen that, when the working temperature of a bearing is reached, the viscosity of the oil has fallen to such an extent that the film is unable to withstand the pressure of the bearing and there is a tendency for the oil to be squeezed out of the bearing. If actual rupture of the oil film occurs, metal-to-metal contact results and seizure will soon follow.

Correct viscosity is, therefore, a matter of primary importance. But there is another property of oil which has to be considered. Some oils possess the property of being adsorbed on to the metal surfaces; that is, being held tenaciously by molecular forces. These resist rupture under pressure, independent of viscosity, but the film which is adsorbed is of submicroscopic thickness and functions in a manner quite different from that of the fluid-film conditions. Lubrication by adsorbed films is referred to as boundary conditions. There are many special cases in industry in which the working temperature or the working pressure (sometimes both) are so high that boundary conditions may occur all the time, and such cases call for special care. It is these cases which the resin-bonded fabric bearings are so well able to meet.

In estimating the performance of these bearings using different lubricants, it is therefore necessary to compare the behaviour of metal bearings under the same conditions of temperature and pressure.

Friction Tests

In apparatus employed for measuring the coefficient of friction a heavy slider was used; this was supported on three hard-steel balls. In this way the area of contact between the slider and the base was very small indeed and the loading, expressed in weight per unit area, was of a very high order. Whatever lubricant is used in such a test, only boundary conditions can obtain.

In the first set of tests the base used was of the laminated cotton-fabric type, resin-bonded; subsequently similar base pieces were used, in which the laminations were of paper. The specimens were specially prepared for these tests by De La Rue Insulation, Ltd., to whom the author wishes to render his thanks. Table 2 shows the coefficient of friction measured under different conditions. For purposes of comparison, the coefficient of friction, measured by the same apparatus under the same conditions but using a cast-iron or steel base, both surfaces being ground true, is included.

Importance of Surface Wetting

Early in this series of tests it was found that the resin-bonded surface was not easily wetted by water. The point is of some importance, for in practice the crucial test of a lubricant is not its performance when conditions are normal, but how it behaves in an emergency; for example, that caused by a higher temperature or pressure than has been provided for. The adsorption of the lubricant by the bearing surfaces is, then, of supreme importance, and there can be no adsorption of a liquid by a solid unless the latter is first wetted by the former. When the resin-bonded surface has water poured over it, the water gathers up into drops or small patches, leaving much of the surface quite dry. This is equivalent to a ruptured film, and while it is not so serious in the case under discussion as it would be in a normal metal bearing, it is obvious that the lubricant cannot function efficiently unless uniform wetting takes place.

There is a further point to be considered. If it is one of the functions of the lubricant to convey heat away from the bearing, it is highly desirable to avoid a film of air, which is a bad thermal conductor, forming between the hot surface and the lubricant. From every point of view, therefore, an endeavour should be made to secure effective wetting.

Experiments with well-known wetting agents were not encouraging, for one reason or another, and trials were made with soap solutions. It was found that a 1 per cent. solution of sodium oleate was entirely successful and proved quite satisfactory over a wide range of temperatures. Incidentally, attention may be called to the marked fall in the coefficient of friction in tests Nos. 1 and 2. This is not an isolated case. It seems to show that, on being exposed to the air, the surface develops a film (of dust maybe, but it is not visible) which offers considerable resistance. It is readily removed by being degreased, washed and dried. Having found the solution of sodium oleate so successful, trials were made using different concentrations. Nothing was gained by using a higher concentration than 1 per cent. On the other hand, further dilution is not to be recommended. A concentration of 0.5 per cent. was definitely less effective.

Colloidal Graphite

Colloidal graphite has proved a valuable addition to lubricating oil for a wide range of purposes and trials were made in this series of tests of colloidal graphite dispersed in water and added to the 1 per cent. solution of sodium oleate. Test No. 10 shows the marked advantage obtained.

In view of the large amount of fluid which must pass through these resin-bonded bearings to effect the necessary degree of cooling which some of the special cases demand, it was felt that this use of colloidal graphite might prove wasteful. Attention was, therefore, directed to a phenomenon which has become very evident in the use of colloidal graphite in metal bearings. It has been found that most metals show a marked adsorptive affinity for graphite, and a bearing which has been run with a graphited lubricant develops a "graphoidal" surface, consisting of a layer of orientated graphite particles which may be quite invisible to the naked eye but which is a very effective aid to lubrication.

Trials were, therefore, made of applying a thin layer of the dispersion to the

bearing surface and allowing it to dry. Tests Nos. 13, 14 and 15 show how much may be gained by this method, which, at the same time, effects a considerable economy in colloidal graphite. Tests Nos. 16 and 17 show that a substantial rise of temperature does not affect the results obtained.

Subsequent examination of the surface of the bearing showed that the graphite had not been adsorbed by the resin-bonded surface, as it would have been under similar conditions by a metal bearing. This means that, under continuous flooding of the bearing, the graphite film would tend to be washed off. Better results would be obtained if the dispersion of colloidal graphite were applied to the metal surface of the shaft within the bearing. On drying, sufficient of the graphite would be adsorbed by the metal to give the required result.

Viscosity of Water

Mechanics who have to deal with the application of lubricating oil will sometimes remark that, when a certain oil becomes hot, it is "as thin as water." This is one way of remarking the fall in viscosity at elevated temperatures. Actually, some oils in common use are much "thinner" than water at temperatures above 30 degrees C. All oils, and most other liquids, show a fall in viscosity with a rise of temperature, but some are much worse than others in this respect. Among a number of lubricating oils which it has fallen to the lot of the present writer to examine, one gave a very steep viscosity-temperature curve, the ratio of the viscosity at 20 degrees C. to that at 65 degrees C. being 21.6, while another gave a ratio of only 12.8 at the same two temperatures. The ratio of the viscosity of water at these temperatures is 2.3. As the temperature at which these resin-bonded bearings are called upon to work is often in the neighbourhood of 80 degrees C., this viscosity-temperature relationship is important.

Incidentally, it may be mentioned that the bearings function satisfactorily at temperatures up to the boiling point of water, and the resin-bonded fabric itself will withstand a temperature of 150 degrees C. without harm. It has already been mentioned that the viscosity of any lubricant at the working temperature must be sufficient to withstand the pressure of the bearing without film rupture, but with this achieved it is desirable that the viscosity at lower temperatures shall not be unduly high, otherwise considerable friction has to be overcome when starting up from cold. Water and water dispersions are ideal in this respect.

Problem of Corrosion

Whenever a ferrous metal is exposed to the action of water the problem of corrosion is sure to arise. The reddish-brown rust which forms under the action of moisture is due to an electrolytic phenomenon resulting from a cell being formed by (a) iron and some impurity usually present in the iron, the water being the electrolyte, or (b) two areas of the same iron being exposed to water of uneven oxygen concentration.

The latter is of special importance in the case of a steel shaft operating in a resin-bonded bearing, using water or a water dispersion as a lubricant. When the mechanism is shut down the bearing is at a temperature well above that of the atmosphere, and consequently the concentration of dissolved oxygen in the water is well below that of cold water exposed to the atmosphere. As the bearing cools down the water at the edges of the bearing will absorb oxygen from the air and thus have a higher oxygen concentration than that within the bearing. All the conditions are established, therefore, for an electrolytic cell, and as the area of iron exposed to the water of lesser oxygen concentration is the anode in such a cell, corrosion takes place inside the bearing, where it is not normally visible.

In addition, corrosion may be set up by foreign substances present in the steel, most of which are likely to be cathodic to iron. The point is sometimes raised in reference to the action of graphite in the

matter of corrosion. Graphite is certainly cathodic to iron, but, like all conductors which are cathodic to iron, it will not set up corrosion unless the circuit of the electrolytic cell is completed. In the case of the graphoidal film, it is very unlikely that the conditions necessary to produce corrosion will be established, and experiment has shown (Stuart, "Engineering," 1938/45/260) that the presence of a graphoidal film on steel, so far from increasing the corrosive conditions, has a small, but easily measurable, influence in the opposite direction.

Whatever the corrosive agent may be, it has been found that the pH value of the electrolyte plays an important part in deciding the rate at which corrosion will proceed. Distilled water, which is quite neutral (i.e., having a pH value of 7), will, in most cases, set up substantial corrosion on the surface of bright steel and a slight acidity (indicated by a pH value of less than 7) will greatly increase the rate of the corrosive attack. On the other hand, if the water is rendered alkaline (pH value of more than 7), the rate of corrosion will be substantially reduced and corrosion may be inhibited altogether. The 1 per cent. solution of sodium oleate, which gave such encouraging results in the friction tests, is definitely alkaline and was found to have a pH value of 8.2.

Tests made by immersing bright steel balls in (a) distilled water, (b) 1 per cent. solution of sodium oleate and (c) 1 per cent. solution of sodium oleate with colloidal graphite added, have shown that, while the ball in the plain distilled water was badly attacked within a few days, showing much flocculated rust suspended in the water, the balls in the solutions of sodium oleate, both plain and with colloidal graphite, showed no indication of corrosion over the same period.

The 1 per cent. solution of sodium oleate would, therefore, appear to be a suitable lubricant, since it not only reduces the coefficient of friction to a minimum, but by readily wetting the surface of the bearing is well suited to act as a cooling agent and, at the same time, greatly reduces, and perhaps inhibits, the corrosive action of plain water.

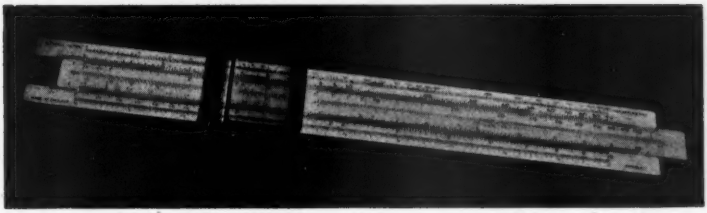
Solving a Storage Battery Defect

THE brochure which Pritchett and Gold and E.P.S. Co., Ltd., of Dagenham Dock, Essex, have issued to record their wartime activities, gives interesting light upon a development of plastics interest.

The plastics experience of this firm go back to the time when they began to make composition battery containers in "Dagenite" material. Subsequently, they have not been slow to realize that some of the newer plastics might find new uses in the construction of storage batteries, one such instance being the unspillable vent, moulded in polystyrene, which quickly became a standard fitting.

Realizing that storage batteries had certain shortcomings, it occurred to Pritchett and Gold that an advance in battery design would be achieved if the usual wood separator fitted between the plates could be replaced by a product manufactured in plastic. Separators made of wood were highly porous, and allowed easy diffusion of the acid, aside from preventing any tendency for the plates to short circuit; their performance in this respect was excellent. Unfortunately, however, such plates were insufficiently resistant to oxidation and acid attack to remain unaffected by service.

In order to overcome the difficulties which were arising, Pritchett and Gold turned their attention to the available thermoplastic materials, bearing in mind that any material to be successful would have to be endowed with microporosity in order to resemble the wood separator. They made their first microporous plastic separator in 1942, but although the pores were sufficiently small, they were not numerous enough to allow the desired flow of acid. By continued research, made more difficult under aerial attack (with the works situated on the home battlefront), development progressed, and eventually the "Porvic" separator emerged in its present form and became standardized for a range of batteries. The material employed is presumably of the polyvinyl chloride type.



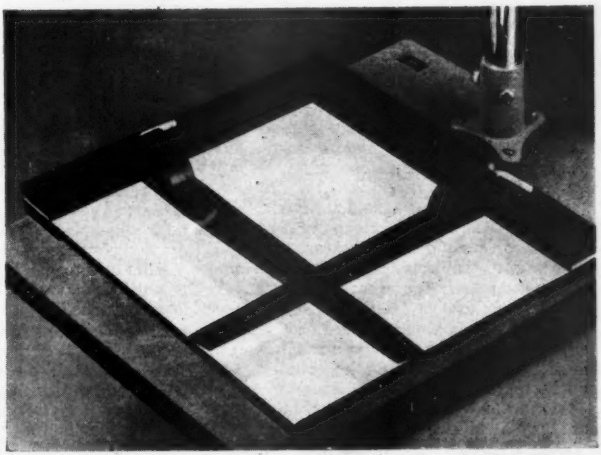
The "Blundell" Slide Rule.

Laminated Material in Unusual Applications

IN our wanderings among manufacturers we have many times found much resourcefulness shown in choice of material for a particular purpose. The masking board for photographic studio use, the subject of one of our illustrations, is an example.

This device, which was supplied to us by the Miscellaneous Trading Co., Ltd., 134 High Holborn, London, is made mainly of Bakelite laminates, with chromium clamping screws to secure the two movable overlapping arms in any desired position. The main parts of the framework are $\frac{1}{4}$ in. thick; thickness of other parts varies from $\frac{1}{8}$ to $\frac{3}{4}$ in., according to the strength desired in the purpose they fulfil. Manufacture was merely a matter of cutting to shape and size and fitting together in much the same way as if the material had been wood—of course, securing the advantages of the plastic laminate against warping or serious mechanical damage in use.

The "Blundell" slide rule, by Blundell Brothers (Luton), Ltd., Chaul End Lane, Luton, is another example of the utility of laminates. This slide rule is produced by a new process (patent applied for). In place of boxwood or other conventional materials, the makers use high-quality phenol-formaldehyde paper laminate which has been well seasoned before treatment to attain perfect equilibrium of moisture conditions. The divisions are process engraved on a specially stoved enamel film, which is claimed to have very high wear resistance.



Masking board for photographic studio use.

Due to the hard wearing qualities of the phenolic resin there is no need for corrective devices such as springs, adjustment screws, etc., to compensate the wear which is inevitable in instruments made of boxwood. The laminate is surprisingly strong, and if dropped to the floor the rule does not suffer damage.

Very accurate master dies are used for the engraving on equipment specially built by the makers of these slide rules, who have found it possible to combine the accuracy of engine-divided divisions with the reliability and clean finish of a highly tooled-up repetition job.

At the moment, five types of 10-in. rules are in production. The makers also hope to produce an interesting universal slide rule which shows all the usual scales on the front of the instrument; such a rule has to be much wider than is possible with the usual boxwood construction, and it is here that plastic laminates anticipate finding further good use. Experimental work on high-quality rulers of flat and oval section is under way.

Book Reviews

The German Plastics Industry. (B.I.O.S. Miscellaneous Report No. 1.) By J. M. De Bell, W. C. Goggin and W. E. Gloor. pp. 378. H.M. Stationery Office. 32s. 6d.

This is a very comprehensive report covering the greater part of the plastics industry in the American, British and French Zones of Germany. Three factories now in the Russian Zone are also included. The report is made up in the usual fashion according to the targets visited, which makes reading rather tiresome. There are quite a few technical mistakes and inaccuracies, such as the statement on Dellatol (a plasticizer). On page 1A-2 Dellatol is stated to be benzolsulphonic-monomethylbutylamide, whilst according to the information given on pages 6-14 it consists of 75 per cent. toluenemethylsulphonamide and 25 per cent. toluenebutylsulphonamide (neither of these statements is probably correct). Many similar instances could be cited.

The authors have probably realized the shortcomings of their report and have reissued it in book form.

German Plastics Practice. By J. M. De Bell. Richardson, Springfield, Mass. pp. 554. 45s.

The 26 chapters of this book are arranged according to subjects, thus obviating the continuous search for cross references. A very comprehensive subject and author index (not supplied with the B.I.O.S. report) and 345 photos are most valuabe features. Unfortunately some of the photos are poorly reproduced and the lack of some additional text referring to the photos is felt as a disadvantage. Chapters on "Reppe Chemistry," test methods, conversion factors, and a glossary containing most of the trade names of German plastics and plasticizers conclude this standard book on present-day plastics manufacture in Germany. In this book the following composition is assigned to Dellatol: page 296, 75 per cent. toluenemethylsulphonamide, plus 25 per cent. toluenebutylsulphonamide; page 523, benzenemethyl and butylsulphonamide.)

"Plastics (Theory and Practice)." By C. C. Winding and R. L. Hasche. pp. 280. McGraw-Hill Book Co., New York and London. 17s. 6d.

The authors' aim was to write a book for the "upgrading" of chemists and chemical engineers in the field of high polymers. In this they have succeeded. They deal with all of the commercial plastics, but experts in the field will find little that would be news to them. Part I deals with the formation and structure of high polymers; Part II with general applications of resins; Part III with resins formed from high molecular weight natural products. Resins formed by condensation reactions, polyethenic resins, silicones, rubber and synthetic rubbers are discussed in Parts IV to VII. Well-selected illustrations, flow sheets and an extensive bibliography covering most of the literature on plastics add to the value of the book, which is one of the McGraw-Hill chemical engineering series.

The index, containing more than 320 trade names and 101 names and addresses of manufacturing firms, will be of great help to American readers. Unfortunately they refer exclusively to American brands and firms so that readers in this country will have little benefit from them.

World's Industry Employs Plastics

GENERAL ENGINEERING

Drop hammer punch dies are produced from cast ethyl cellulose plastic by Douglas Aircraft Co. ("Modern Machine Shop," 1947/July/166.)

Metal Bonding.—Araldite, developed by Ciba, Ltd., melts at 160-250 degrees F. and cures between 266-488 degrees F.; it has proved to be an excellent bonding material, especially for metals. ("Metal Industry," 1947/Aug. 1/85.)

Protection of metal surfaces is attained by "Spray-Peel" stripable plastic compound, developed by Eronel Industries, of Los Angeles, California. It is applied by brushing or spraying, and dries quickly to an adhesive film. The new compound is non-toxic and has high moisture resistance. ("Machinery (N.Y.)," 1947/July/176.)

New "sandwich" technique is said to solve the problem of joining non-porous surfaces with a practical adhesive. The adhesive "Plasgon" is spread over the surfaces to be joined and a layer of fabric is then inserted before bringing the two surfaces together. ("Mill and Factory," 1947/July/214.)

Structural Properties.—Three engineers from the Development Laboratory of Bakelite Corporation have compared plastics, as regards mechanical properties, with common structural metals. Their findings cover stress strain relations, notch sensitivity, impact resistance, fatigue strength, damping capacity, specific gravity, long-time tensile, strength at higher temperatures, water absorption, coefficient of thermal expansion. ("Machine Design," 1947/July/112.)

Design practice for moulded plastics, referring in specific items to the ASTM standards, is reviewed by J. Delmonte. ("Machine Design," 1947/**19**/151.)

Influence of injection temperature on the economy of the injection die casting and the mechanical strength of plastics, known as Trolitul III and Trolitul EF, has been investigated by J. Hammersbach. ("Kunststoffe," 1946/**36**/81.)

Cellular plastics have high strength-weight ratios; according to Ch. A. Breskin this opens possible applications which may lead to extended uses if prices can be made more competitive. ("Scientific American," 1947/**177**/119.)

MISCELLANEOUS

Ornamental Carving.—New technique, making use of only three simple tools ($\frac{3}{16}$-in. end mill, twist drill with sharp point, and $\frac{1}{4}$-in. ball cutter), is described in detail in "Popular Science Monthly." (1947/Aug./160.)

Microfilms of fire-resisting cellulose acetate were extensively used during the war for the duplication of plans and drawings. At present, tedious work in copying ticket stubs is saved by a similar microfilm technique. ("Scientific American," 1947/**177**/60.)

Combination funnel made in two plastic sections, which are joined together by friction welding, is said to be ideal for handling large volumes of liquid when filling small-mouthed bottles. ("Scientific American," 1947/**177**/130.)

Cold-setting plastic, "Plexine," is available in eight transparent and nine opaque colours; the hardening is accelerated by a compound called "Kwickplex."

Composite black and white objects can be produced easily. (" Mechanics," 1947/Aug. 15/291.)

Surface temperature of rigid plastics at the moment of ignition has been investigated by E. M. Schoenborn and D. S. Weaver, according to a more rigorous method than usual. Flammability data are presented for over 25 different materials under varying test conditions. (" A.S.T.M. Bulletin," 1947/May/80.)

Brewers' casks have recently been manufactured in moulded plywood, replacing Russian oak usually employed. The new plywood cask is constructed from six identical segments or staves, with two end units; phenolic resin adhesive with an economical glue spread is used. (" Machinery Lloyd," 1947/June 7/101.)

Fully automatic moulding machine for thermosetting plastics combines production speed with accurate automatic time control of each stage in the cycle. The new " Hy-Jactor " produces the preform, preheats it, and moulds and cures it in uninterrupted sequence. (" Production Engineering and Management," 1947/June/78.)

Low-pressure resins were discussed by C. E. Bacon in a paper before a meeting of the Society of the Plastics Industry. (Abstract in " Product Engineering," 1947/June/125.)

Car Windows.—G. B. Watkins and J. D. Ryan have tested " Lucite," " Plexiglas " and " C R 39 " for their suitability as car windows. The plastic windows were installed in a saloon car and subjected to daily driving, and thus compared with windows made of the usual safety glass. Whereas the surface of the plastics deteriorated quicker, all three showed a considerable resistance to impact. (" S.A.E. Journal," 1946/Dec./54.)

Testing Procedure.—After critical comparison of the methods for the determination of chloride content of polymers, K. Stoeckert develops a method which is based on the sodium-peroxide-soda fusion product, and which is said to bring considerable savings in testing time. (" Kunststoffe," 1947/**37**/53.)

Handicraft Technique.—T. G. Horner reports his experience in the turning and glueing of Catalin. (" Mechanics," 1947/Aug. 29/334.)

Textile applications of plastics during the past two years have been reviewed by D. S. Plumb, of Monsanto Chemical Co. The entry of plastics into the textile field has been extremely complex and confusing, but more co-ordinated activities are predicted. (" Mechanical Engineering," 1947/July/602.)

Reinforced plastic motorcar was described by L. A. Werner before summer meeting of Society of Automotive Engineers, June, 1947. (" Mechanical Engineering," 1947/July/604.)

Acrylic-resin plating barrel of hexagonal shape has recently been produced for treatment of metal parts by the tumbling method. The objects are placed in a perforated container. The gears of the machine are also made of acrylic resin. ("Machinery," New York, 1947/**53**/197.)

Vinylite finishes in a wide range are being manufactured by Watson Standard Co., Pittsburgh, Pa. ("Machinery," New York, 1947/**53**/196.)

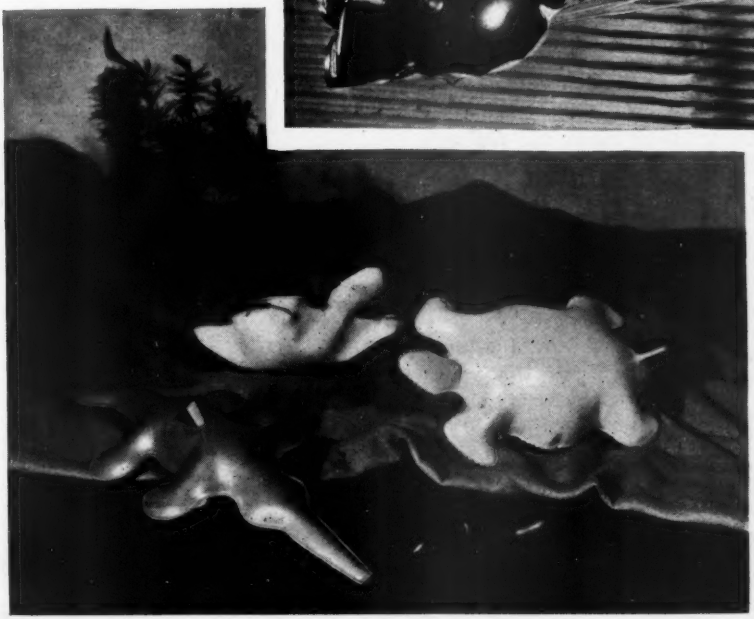
SOURCES OF REFERENCE

We wish to remind readers that the sources of reference from which these pages are compiled are not, in general, retained in this office. We cannot, therefore, undertake to supply such originals. Nevertheless, most of the foreign journals referred to are available in the Patent Office Library (Southampton Buildings, Chancery Lane, W.C.2) and in the Science Library (South Kensington). Photo-duplicated copies of articles may be obtained from the Photostat Dept. of the Patent Office.

Inflated Toys for the Beach

The use of vinyl plastics for inflated toys has broken new ground in this country. These fishes are being produced by Plysu Products, Ltd., of High Street, Egham, Surrey, as part of a range of toys for the export market, and are fabricated by high-frequency welding. The vinyl sheet was made by Olympic Industries, Ltd., using "Vybak" compounds supplied by the Vinylite Unit of Bakelite, Ltd.

The turtles and the miniature crocodile, the subject of our second illustration, are from the same source. Because the welding is said to be so successful, these toys, when inflated, are fully able to stand up against the strain of rough usage by children playing on the beach.



Cellulose Acetate Plastics

V.—Manufacture of Cellulose Acetate (contd.)

By
Vivian Stannett

CELLULOSE acetate is a white solid which varies in general appearance, according to the method of manufacture and precipitation. The normal commercial product consists of small white flakes, often accompanied by a great deal of dust. Cheaper grades often consist of hard, horny fragments, whilst the best quality is often marketed as white fine granules, substantially free from dust. Cellulose triacetate prepared by the non-solution methods is a fibrous material, a little like cotton-wool in appearance.

The general properties of cellulose acetate are given in Table 1. All grades are odourless, tasteless and non-toxic; they soften and char on heating, but do not melt. A number of grades are commercially available, which vary with respect to their viscosity and degree of acetylation. In addition, grades vary in quality, as shown by their colour and clarity in solution and their stability to heat, light and exposure. They are readily hydrolyzed back to cellulose with acid and alkalis, this susceptibility diminishing somewhat with increasing degree of acetylation.

Degree of Acetylation

The degree of acetylation is normally expressed as the percentage of combined acetic acid present in the sample, and is determined by saponification methods. This involves the quantitative removal of the acetyl groups by hydrolysis, usually in an alkali medium. The amount of alkali taken up in converting a known weight of the cellulose acetate back to cellulose is measured in the normal manner, and from this the percentage of combined acetic acid present in the original sample can readily be calculated. Owing to absorption of alkali by the regenerated cellulose, a slight modification of the titration method is found to be necessary. Acid hydrolysis followed by the steam distillation of the acetic acid produced and its subsequent estimation in the distillate is also occasionally used, and is reported to give very accurate results.

Cellulose has three hydroxyl groups per each repeating anhydro-glucose unit, and the completely acetylated triacetate corresponds to 62.5 per cent. combined acetic acid. The diacetate corresponds to 48.8 per cent., and the monoacetate to 29.4 per cent. combined acetic acid. In practice, for use in plastics, only grades

Table 1.—General Properties of Cellulose Acetate.

Appearance	white flakes, fibre or granules
Specific gravity	1.33–1.36
Penetration melting point	180–230 degs. C.
Moisture absorption of flake	11–18%
Acidity as free acetic acid	approx. 0.005%
Sulphate content	approx. 0.06%
Refractive index*	1.47–1.48
U.V. light transmission*	92%
Dielectric strength*	1,200–1,400 volts/mil.
Dielectric constant 10^3 cycles*	4–6
Volume resistivity*	6×10^{12} ohm-cub. cm.

*Properties given are or unplasticised film.

Table 2.—Effect of Degree of Acetylation on Dimensional Stability

Combined acetic acid content	Treatment of Films	Per cent. deformation at end of 30 days
52.3	Washing 5 days in running water at 20 degs. C.	0.3
59.5	Washing 5 days in running water at 20 degs. C.	0.065
52.3	Washing 8 days in running water at 35 degs. C.	0.1
59.5	Washing 8 days in running water at 35 degs. C.	0.07
52.3	Treatment for 30 mins. in water at 70–80 degs. C.	0.185
59.5	Treatment for 30 mins. in water at 70–80 degs. C.	0.04
55.9	Treatment for 30 mins. in boiling water	0.025
57.6	Treatment for 30 mins. in boiling water	0.015
59.5	Treatment for 30 mins. in boiling water	0

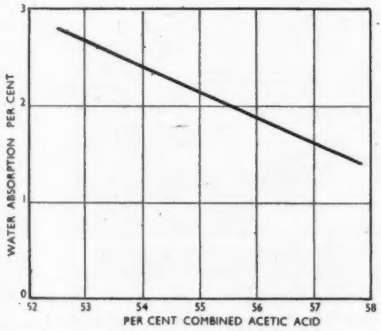


Fig. 1.—Effect of degree of acetylation on water absorption.[3] (31 per cent plasticizer content.)

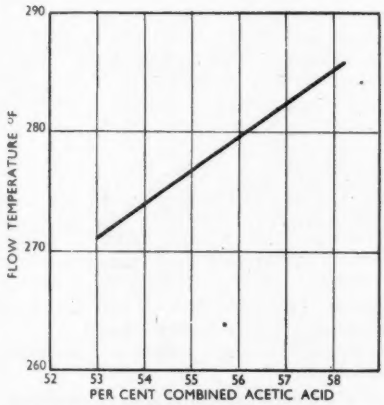


Fig. 2.—Effect of degree of acetylation on flow temperature.[3] (31 per cent plasticizer content.)

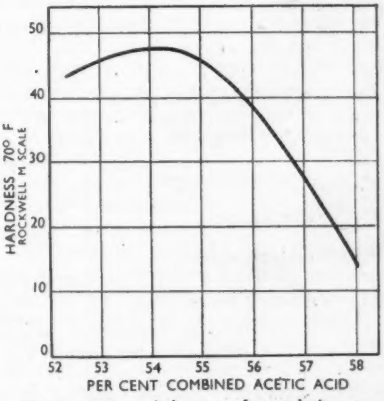


Fig. 3.—Effect of degree of acetylation on hardness.[3] (31 per cent plasticizer content.)

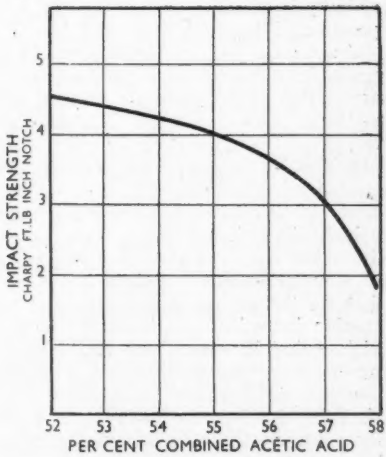


Fig. 4.—Effect of degree of acetylation on impact strength.[3] (31 per cent plasticizer content.)

containing more than about 52 per cent. combined acetic acid are found to be of value. The normal grade for use in plastics contains between 52 and 54 per cent., whilst for use in lacquers and films, grades containing between 55 and 56 per cent. are found to be more suitable.

The moisture resistance is found to improve considerably with increasing acetic acid content, as also is the resistance to heat. Consequently, there is a growing tendency to use higher acetyl grades, even though their advantages are slightly offset by increased difficulties in working. As the acetic acid content increases, it is found that the corresponding plastics have an increasingly high softening point, whilst the impact strength tends to drop in value. These effects are shown graphically in Figs. 1 to 4. The fully acetylated product is also finding a growing use for certain purposes, where

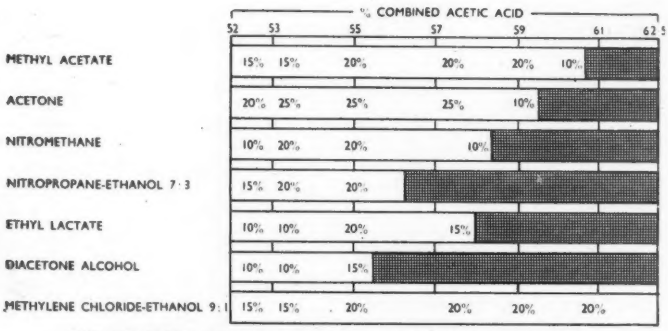


Fig. 5.—Solubility of low-viscosity cellulose acetate. (Reproduced in simplified form from "Hercules Cellulose Acetate," by courtesy of Hercules Powder Co.).

its superior water resistance and heat stability is of value, such as for the preparation of insulating film and foils.

As would be anticipated, products made from grades of higher degree of acetylation have greater dimensional stability. This fact is well illustrated by the figures given in Table 2, which were obtained by Charriou and Valatte and quoted by Yarsley. Thin acetate films have quite a high electrical resistivity and a high dielectric strength. These values depend to some extent on the proportion of absorbed moisture present, and therefore on the degree of acetylation. The specific inductive capacity is also rather high, being between three and four at normal temperatures when dry. Possibly the most striking effect brought about by changing the degree of acetylation is on the solubility characteristics of the cellulose acetate.

Solubility

All grades of cellulose acetate are soluble only in a limited range of solvents. The solubility is fundamentally changed with change in degree of acetylation, and is to a lesser extent also dependent on viscosity. This dependence on degree of acetylation has already been stressed with regard to the distinction between the chloroform soluble fully acetylated product and the acetone soluble partially acetylated grades. With further removal of acetyl groups, a grade soluble in water is reported to be possible.[3] The normal secondary grades of cellulose acetate of medium viscosity, such as are extensively used for the manufacture of plastics, are soluble only in acetone among the more common organic solvents. In addition, hot acqueous alcohol and a mixture of benzene with alcohol have a gelling effect, but do not give true and stable solutions. Some esters, such as methyl acetate and ethyl lactate, are also good solvents, as are a number of odd solvents, including dioxane, pyridine and diacetone alcohol.

The solubility of low viscosity cellulose acetate of various degrees of acetylation is shown diagrammatically in Fig. 5 for

Table 3.—Effect of Solvent on Viscosity of Cellulose Acetate Solutions.[4]

(By courtesy of Hercules Powder Co.)

Solvent	Viscosity cps. of 9% solution
9 Acetone : 1 Methanol	40
9 Acetone : 1 Ethanol	42
Acetone	46
Methyl acetate	62
9 Methylene Chloride : 1 Ethanol ..	84
8 Nitromethane : 2 Ethanol	109
9 Nitromethane : 1 Ethanol	120
8 1-Nitropropane : 2 Ethanol ..	185
Diacetone alcohol	650
Ethyl lactate	720

several organic solvents. The limited solubility is, of course, a great advantage for its use in plastics, as it confers a good measure of solvent resistance on the plastics article, including petrol, oil and grease resistance. The chief drawback to the fact that only a limited range of solvents are available, is found in the field of film and lacquer production and formulation. More recently, the development of the nitro-paraffins has helped in this latter connection, as some of this series are quite good solvents for the lacquer grades of cellulose acetate and are also of medium boiling point. Nitropropane and nitromethane are likely to be particularly useful.

As a general rule, the efficiency or power of a solvent can be judged from the viscosity of the resulting solution, and the lower the viscosity the more active the solvent. Some comparative figures, illustrating this point, are given in Table 3. These figures illustrate also the great value of cosolvents with cellulose acetate. These are not solvents for cellulose acetate when used alone, but improve the powers of the true solvents when added to one. This is shown particularly by the resulting drop in viscosity. A reasonably high proportion of these cosolvents can be added, often amounting to 10 to 15 per cent., or even more in some cases. A reasonably high proportion of diluents can also be tolerated by cellulose acetate dopes, particularly with the lower viscosity grades. Simple aromatic hydrocarbons, such as benzene and toluene, are among the most popular diluents.

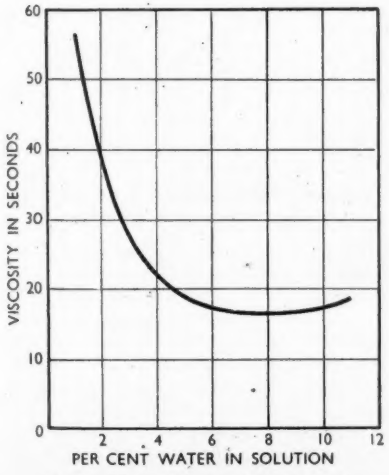


Fig. 6.—Effect of water on viscosity of cellulose acetate solution in acetone (20 per cent solution).

Solutions of cellulose acetate deposit clear transparent films, when the solvents are allowed to evaporate, although an excess of cosolvent or diluent in the solutions causes cloudy and opaque films. Blushing can also be produced by incorrect solvent balance, in the same way as is the case with nitrocellulose lacquers. This effect is not quite the same as caused by the presence of an excess of non-solvent, and is due to the condensation of water on the film surface, caused by chilling, resulting from too rapid evaporation. With the other case, the whitening is caused by the evaporation of true solvents more rapidly than the non-solvents, thus causing a premature precipitation of cellulose acetate in the film rather than a smooth deposition. This means, of course, that a clear solution does not necessarily signify that a clear film will be produced on evaporation.

A good example of this is to be found in the case of the addition of water to solutions of cellulose acetate in acetone. More than 12 per cent. of water can be added and a clear solution produced, but if more than 5 per cent. or so is present,

Table 4.—Effect of Water on the Clarity of Films cast from Cellulose Acetate Solutions in Acetone. (25% Concentration)

Water content (per cent)	Viscosity (seconds)	Condition of Film cast and dried at 35°C.
1	56.5	clear transparent
3	26.6	clear transparent
4	22.4	clear transparent
5	18.7	clear transparent
6	18.0	cloudy
7	16.5	white opaque
8	16.8	white opaque
11	17.8	white opaque

All solutions were clear and bright.

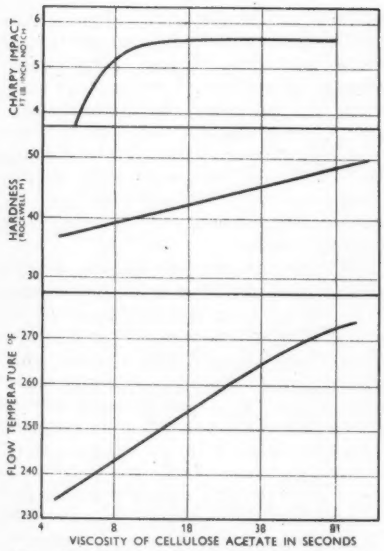


Fig. 7.—Effect of viscosity of cellulose acetate on physical properties of the plastic.[3]

cloudy and opaque films result on drying out. This effect and the effect of the addition of water on the viscosity of these solutions are shown in Table 4 and Fig. 6 respectively.

Viscosity

The viscosity of cellulose acetate in solution is a measure of the length of the molecular chains, and consequently has an important effect on its properties. It is usually measured in practice by the falling-ball method and expressed in seconds, this figure being the time taken for a standard diameter steel ball to fall a specified distance in a tube containing the cellulose acetate solution. The standard Hercules method uses a $\frac{5}{16}$-in. diameter steel ball and a 10-in. drop in a 20 per cent. solution of the cellulose acetate. The solvent, of course, must also be specified.

Commercial grades can vary in viscosity, as determined by this method at 25 degrees C. from a few seconds for lacquer grades to over 200 seconds for very high viscosity types. Medium viscosity grades for use in plastics run from about 20 to 60 seconds for a 20 per cent. solution in a 90 : 10 acetone-ethanol mixture. Generally speaking, the solubility decreases with increase in viscosity, and this effect is illustrated by its use for separating fractions of a different viscosity from a commercial sample. This is carried out by fractional precipitation, usually from an acetone solution, by the controlled and progressive addition of a non-solvent such as water.

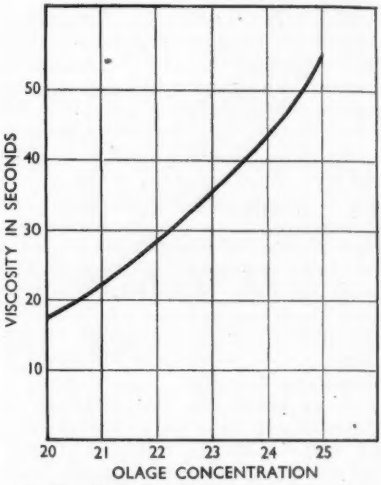


Fig. 8.—Viscosity concentration curve for cellulose acetate solutions in acetone.

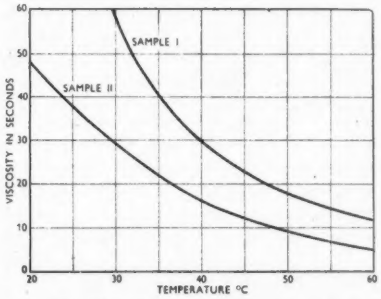


Fig. 9.—Viscosity temperature curves for cellulose acetate solutions in acetone (30 per cent concentration).

Flow temperature, hardness and

elongation tend to increase steadily as the viscosity increases. Impact strength and tensile strength tend to increase with increase in viscosity rapidly at first, and then little further effect is noticeable. Some of these effects are illustrated in the three graphs given in Fig. 7.

Too high a viscosity is a great disadvantage in solution methods of fabrication, owing to the fact that only a low solid content solution is possible, and consequently a very large volume of solvent is necessary to lay down a film of the required thickness. The viscosity of cellulose acetate solution increases steeply with increase in concentration, as shown by the graph given in Fig. 8. The corresponding graphs for the same sample in different solvents and solvent mixtures run almost parallel. This is very useful, as it enables the viscosity behaviour of a sample in a particular solvent to be predicted from one measurement. Viscosity also drops rapidly with increase in temperature, and this effect is illustrated by the two graphs given in Fig. 9.

Compatibility

Cellulose acetate is compatible in varying degrees with a large number of plasticizers, and this aspect of plastics technology will be discussed more fully in a subsequent section. Very few resins are fully compatible, although certain phenol formaldehyde resins and some special-type proprietary resins show limited compatibility. These are not used in plastics formulation, but are widely used in the preparation of lacquers, to increase the hardness, gloss and adhesion of the lacquer film, and also to build up the solid content of the lacquer. Cellulose nitrate is more or less completely compatible with cellulose acetate, although other cellulose esters, mixed esters and ethers are incompatible.

In general, grades of cellulose acetate of different acetyl value are compatible with each other, although too great a difference is to be avoided when blending.

Stability

The stability of cellulose acetate to light, heat and moisture is of great importance and is a subject which has received considerable attention. The development of the injection-moulding method has also meant that a highly heat-stable product is necessary in order that the moulding powder can stand up to the comparatively high moulding temperature without loss of colour or strength. The stability to light is also important, especially when the cellulose acetate is destined for use in transparent sheet products.

The stability of cellulose acetate to heat has been found to be greatly influenced by the amount of residual sulphate and acidity present, and in addition to stability tests, these two quantities are also usually estimated. A good-grade acetate should be able to be heated up to at least 180 degrees C. for more than one hour without discoloration. Once ignited, acetate film burns slowly and quietly in a somewhat similar manner to wood and paper. The penetration softening point varies according to the degree of acetylation and viscosity between about 180 degrees C. and 240 degrees C. Heat stability can be estimated to some extent by determining the point at which distinct discoloration occurs when a sample is gradually heated at a standard rate in a carefully cleaned and dry tube.

A further measure of stability is given by estimating the amount of acidity produced on heating the sample with distilled water in a sealed tube at 100 degrees C. for several hours. Residual combined sulphate is estimated by first destroying the organic matter either with acids, such as nitric acid or aqua regia, or by fusing with sodium carbonate and an oxidizing agent, such as potassium nitrate. The sulphate is then determined by the usual barium sulphate precipitation method. The determination of the residual free acidity is rendered rather complicated, owing to the difficulty of separating quantitatively the free acid from the sample. This cannot be achieved by simple washing methods, and the most efficient way is to dissolve the sample in acetone, precipitate by pouring into water, and estimating the acidity of the water

(*Continued on page 546.*)

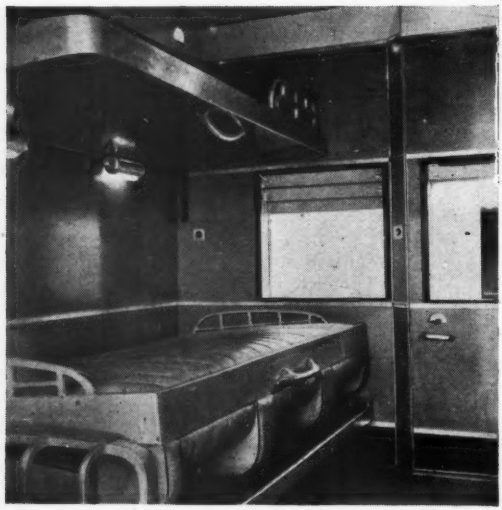
Modernized Interior for Indian Railway Coaches

THE first of a series of upper-class coaches to be completed on an initial post-war programme in the Moghalpura (Punjab) workshops of the N.W. (Indian Government) Railway has made extended use of laminated plastic panelling for interior finish.

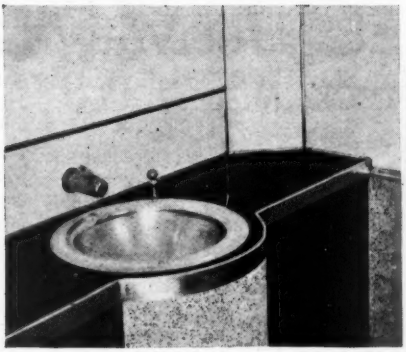
Hitherto, on the Indian Government Railways, there has been in operation a system of reconditioning, whereby carriages are given a 100 per cent. examination and overhaul between the age group of 15-20 years and made fit to run out their remaining life of 15 years without further heavy repair; this system was instituted before the last war and has proved to be practically sound, though in no way eliminating smaller repairs of all types which periodically may be necessary. As a post-war project, however, an effort has been made to completely modernize the interiors and to install fittings which offer greater passenger comfort, ease of operation and resistance to theft. Exploratory work and design in attaining these ends has been the responsibility of Carriage Research staff; coaches recently placed in service represent the culmination of work extending over the past 18 months.

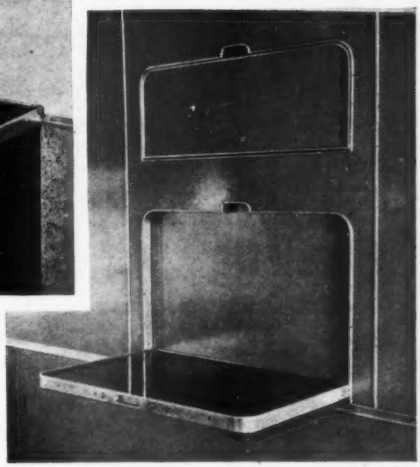
With regard to seating accommodation, for the first time in the first-class compartments the bench-type seat has given way to the individual, contoured seat, complete with head and folding arm rests. For conversion to a bed, the balanced back squab is pulled down as one unit, thereby revealing a fully sprung bed 3 ft. wide. Simultaneously with this movement the bottom seats move rearwards as one unit and so afford the necessary clearances. The upper berth, which folds flush with the wall, is of the semi-balanced type; on opening, there is automatically set up a protection rail at the head end. Upholstery coverings are in imitation leather of antique ivory tone,

(Above) View of first-class coupe, arranged for day seating.



(Left) First-class coupe arranged for sleeping. Here metal alloys are used for bunk frames and handles, with "Warerite" laminated for walls and top bunk panels.





(Above) In the first-class toilet "Warerite" is used for surface of walls and surround to basin.

(Right) Flush-fitting tables are provided in the first-class coupe, wall surface and tables being of "Warerite" with "eggshell" finish.

piped in green. In the second-class compartment conditions are more austere, "Masonite" being used up to waist rail and "Warerite" laminated above, with imitation leather cloth of green colour.

Our object in publishing the accompanying photographs has been to emphasize internal finish. Here the elimination of wood screws for internal fitments was considered a necessity. At the same time, opportunity was taken to avoid the use of paint; in its place there has been a satisfactory blending of anodized aluminium fittings and coloured plastic panels. Extensive survey of the possible alternatives to teak wood panelling—then in short supply—led to the decision to utilize plastic panels, which could be obtained in sheets 5-32-in. thick to colours specified by the Indian administration. A colour scheme of sea-green for the walls, with a 6-in. floor border of black plastic, and cream-coloured plastic for the ceiling, was chosen to give an air of greater spaciousness. The method of fixing by anodized aluminium mouldings offered a clean and satisfying appearance.

Looking in greater detail at the first-class toilet, we find this panelled from the waist rail upwards, including the ceiling, in cream-coloured "Warerite," and the non-folding wash-bowl is set in a shelf of black "Warerite" sheet. The second-class compartment is panelled up to the waist rail in composition hard board, with sea-green "Warerite" above and for the ceiling, methods of attachment being as in the first-class compartment. In the toilet attached to the second-class a further innovation has been made by the provision of special linoleum fixed to the wall by adhesive and trimmed with aluminium beading.

All the plastic panels employed have an "eggshell" finish, and by suitable sizing they required no pre-forming for the ceiling attachment. The use of these materials for the first time on Indian railway coaching stock will be watched with interest, especially as the climatic conditions operating are notably severe.

BRITISH XYLONITE CO., LTD.—Mr. T. L. Birrell, sales director, B.X. Plastics, Ltd., and Mr. H. Senior, managing director of Casceiloid, Ltd., have been appointed directors of British Xylonite Co., Ltd.

Furfural and its Derivatives

By H. RONALD FLECK, M.Sc., F.R.I.C.

THE recent announcement of the successful synthesis of nylon from furfuraldehyde has served to refocus interest upon this remarkably reactive aldehyde. It is proposed to recapitulate in this article some of the known facts about furfural and to examine further possibilities of its exploitation in the plastics field.

The synthesis was announced by Dr. O. W. Cass, of E. I. Du Pont de Nemours, on March 27, 1947, and the steps in the synthesis are an example of the elegance of modern organic syntheses. Since the raw material for the manufacture of furfural is agricultural waste, such as corn cobs, oat husks and cottonseed hulls, it would seem that the claim of nylon—" coal, air and water "—will need some modification. The synthesis is of considerable importance to the whole industry, since a very large amount of phenol will be released from the duty of manufacturing nylon and become available to a market which is starved of this essential commodity. The necessary waste material is abundant on all farms, and since the production of the aldehyde is relatively simple, the supply position would appear to be adequate.

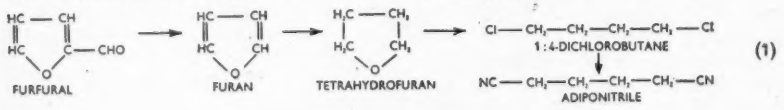
The aim of the new Du Pont synthesis is to produce adiponitrile, hitherto produced from phenol via cyclohexanol and adipic acid to the nitrile. The outline of the new process is as follows:—

Furfuraldehyde is subjected to catalytic decomposition to the five-membered ring compound furan. This, in turn, is hydrogenated to form tetrahydrofuran, which may be regarded as the internal ether (or cyclic ether) of tetramethylene glycol. The next stage results in the opening of the ring, tetrahydrofuran reacting with hydrogen chloride to form 1:4-dichlorobutane. Adiponitrile is made by treatment of 1:4-dichlorobutane with sodium cyanide (reaction 1).

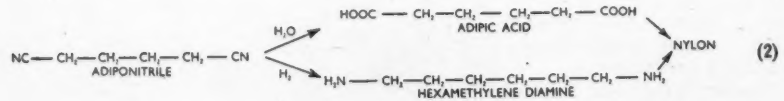
From this point onwards the synthesis of nylon is unchanged. Adiponitrile is hydrolysed to adipic acid and hydrogenated to hexamethylene diamine; these two substances are then reacted to form the polyamide (reaction 2).

The details of the synthesis are worthy of note, since they illustrate the smooth way in which vapour phase reactions have been utilized in order to reduce to a minimum the amount of handling necessary.

In the first stage, the aldehydic side chain is removed from furfural as carbon monoxide. This is achieved by passing a mixture of the vaporized aldehyde and steam over a heated zinc-chromite catalyst, which contains either manganese or iron (U.S. Pat. 2,374,149), the reaction temperature being maintained at 400 degrees C. The reaction product is a mixture of furan and unconverted furfuraldehyde.



(1)



(2)

Furan may be converted quantitatively into tetrahydrofuran by reaction with hydrogen in the presence of suitable catalysts (U.S. Pat. 1,006,873); the process, being vapour phase, is capable of continuous operation.

Three methods of converting tetrahydrofuran to 1:4-dichlorobutane are available, all three giving good yields of high-purity materials. They are: (a) Heating tetrahydrofuran and hydrochloric acid solution under pressure, with or without catalysts; (b) passing tetrahydrofuran and hydrogen chloride through dehydrating agents, e.g., sulphuric acid or zinc chloride, at atmospheric pressure (U.S. Pat. 2,218,018); (c) reacting tetrahydrofuran and hydrogen chloride in the presence of amine hydrochlorides which appear to have a catalytic effect.

Finally, 1:4-dichlorobutane is reacted with sodium cyanide in the presence of a suitable solvent to form adiponitrile. This reaction is probably one of the most important complete syntheses to be published since nylon itself first excited the plastics industry.

The reactions leading up to the manufacture of furfuraldehyde and some of its more significant reactions will now be considered.

Furfuraldehyde

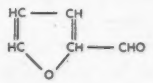
Furfuraldehyde (3) is a colourless liquid, darkening in contact with air; boiling point 161.7 degrees C., melting point −36.5 degrees C., specific gravity 20 degrees C./4 degrees C.

Agricultural waste materials, such as oat hulls, cottonseed hulls and corn cobs, are rich in polysaccharides, amongst which are the pentosans formed by condensation of $C_5H_{10}O_5$ units. When hydrolysed in the presence of acids, the pentosans are broken down into the pentose units, forming sugars of the type of arabinose and xylose, which are aldopentoses having the constitution $CH_2(OH)CH(OH)CH(OH)CH(OH)CHO$. Further heating with acid causes dehydroxylation of the pentose to give furfuraldehyde. The structural formulæ for the dehydroxylation show clearly the course of the reaction (4).

In practice, the pentosan-containing material is digested for some time under 70 lb. pressure with dilute sulphuric acid and then distilled in steam. The distillate separates into two layers, one of which is a saturated solution of furfuraldehyde in water (containing 8.3 per cent. by weight of aldehyde), whereas the lower layer is a saturated solution of water in furfuraldehyde (containing 95.2 per cent. by weight of aldehyde, both concentrations being at 20 degrees C.). These layers are separated and each is worked up by fractional distillation until anhydrous aldehyde is obtained.

Inorganic salts are, in the main, almost insoluble in furfuraldehyde, but many organic solids are soluble and the aldehyde is miscible with most organic solvents.

On standing, furfuraldehyde undergoes autoxidation to furoic acid, this change being accompanied by a darkening of colour due to resin formation. Tertiary



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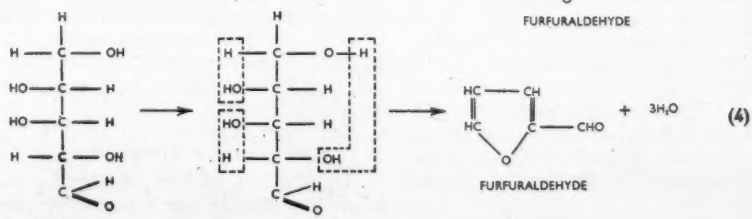

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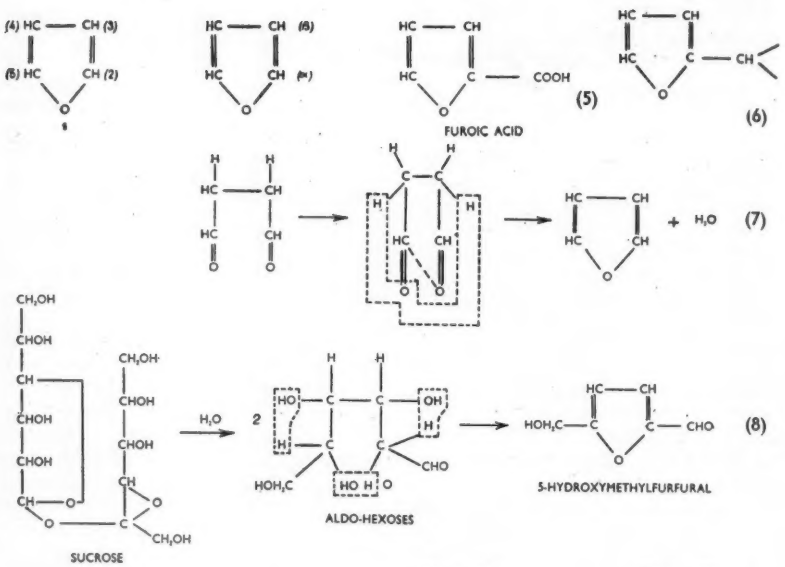
FURFURALDEHYDE



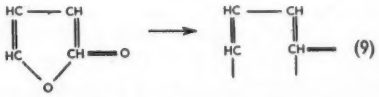
amines in small quantities will retard this autoxidation, but for most technical processes it is of little consequence. The autoxidation is not a simple change to furoic acid, as in the analogous benzaldehyde and benzoic-acid case, since Reichstein has isolated formic acid, β-formyl acrylic acid, its polymers and condensation products from a dark sample of furfuraldehyde. It would appear, therefore, that some rupture of the furan ring also takes place.

Nomenclature of Furan Derivatives

There are two accepted methods of designating the structure of the furan derivatives: (a) By numbering in an anticlockwise direction from the oxygen atom in the ring, and (b) Greek lettering (restricted to mono-substitution products).

Thus, furoic acid is systematically named 2-furancarboxylic acid. The acyl radicle (6) is designated the furoyl radicle when the side chain is attached in the 2-position and 3-furoyl when attached in that position.

According to the systematic nomenclature, furfuraldehyde would be more properly referred to as 2-furaldehyde, but it has kept its original name by virtue of common usage.

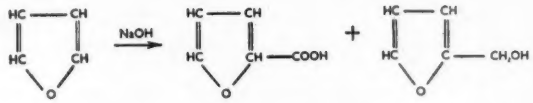


Furan Compound Formation

Furan compounds have been prepared by many classic methods of ring closure, but for industrial purposes they are almost always produced from furfuraldehyde. As examples of ring closure, we may cite: (i) Formation of furan by heating succindialdehyde and water at 180 degrees C. (reaction 7). (ii) Formation of 5-hydroxymethylfurfural from sucrose (reaction 8); 5-hydroxymethylfurfural is oxidized almost quantitatively to lævulinic and formic acids in the presence of acids.

Reactivity of Furfuraldehyde

The structure of furfuraldehyde contains three double bonds (including the double bond in the carbonyl group), and



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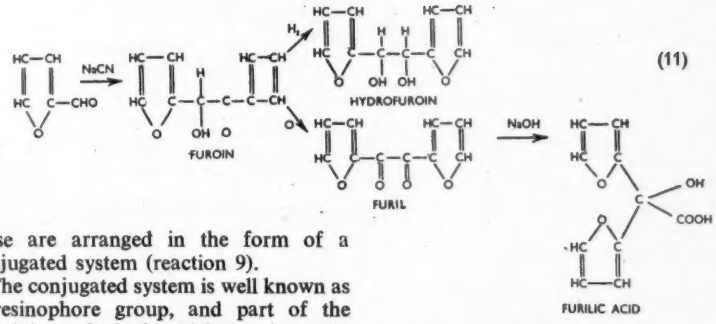


(11)

these are arranged in the form of a conjugated system (reaction 9).

The conjugated system is well known as a resinophore group, and part of the reactivity of furfuraldehyde in resin reaction is undoubtedly due to this configuration. The aldehyde group is also extremely reactive. The reactions undergone by furfuraldehyde may—for our purpose—be divided into two sections: (a) Normal organic reactions, (b) reactions of interest to the plastics industry.

(a) Normal Organic Reactions

(i) *Canizarro Reaction.*—As with benzaldehyde, furfuraldehyde is converted into the corresponding alcohol and acid by means of strong caustic-soda solution, the products being furoic acid and furfuryl alcohol (reaction 10).

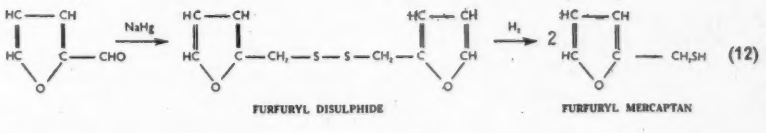
(ii) With sodium cyanide in alcoholic solution, furoin is formed. Furoin may be oxidized to furil and thence transformed to furilic acid by means of caustic soda, or it may be reduced to hydrofuroin (reaction 11).

(iii) With sodium sulphide, furfuraldehyde gives furfuryl disulphide, which may be reduced to furfuryl mercaptan (reaction 12).

(iv) *Friedel-Crafts Reaction.*—Substitution of alkyl groups in the nucleus. The alkyl group enters position 4 in the presence of anhydrous aluminium chloride (reaction 13).

(b) Reactions of Interest to the Plastics Industry

Furfuraldehyde undergoes a number of reactions which are similar in type to some of those which lead up to already familiar plastic materials. It is probable



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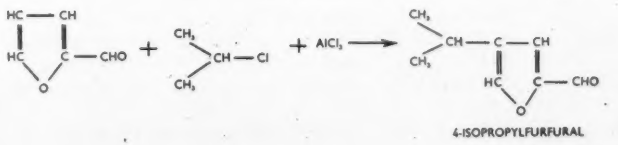
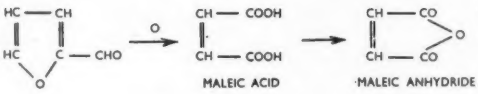


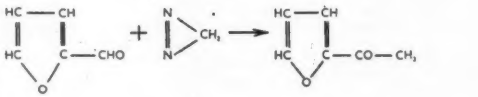
(13)

that modification of many of these plastics may be brought about by the introduction of the furan ring with its resinophore grouping.

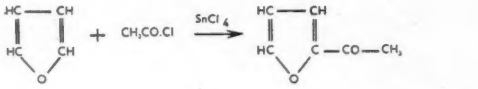


(14)

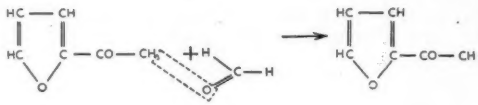
(i) Vapour - phase oxidation to maleic acid and thence to maleic anhydride (reaction 14).


(15)

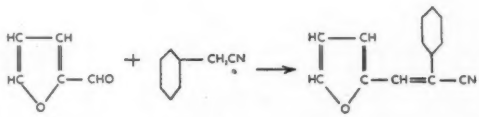
(ii) Furfuraldehyde and diazomethane react to give furyl methyl ketone. It is possible that this substance may react similarly to methyl ethyl ketone (reaction 15).


(16)

This ketone can also be prepared by reacting furan with acetyl chloride in the presence of stannic chloride as a catalyst (reaction 16).


(17)

With formaldehyde, furyl methyl ketone yields furyl vinyl ketone. The corresponding vinyl ketone from methyl ethyl ketone gives rise to the M.E.K. organic glasses (reaction 17).


(18)

(iii) Benzyl cyanide and furfuraldehyde react to form α-phenyl-β-furylacrylontrile (reaction 18).

(iv) Furfuraldehyde reacts with acetaldehyde to form β-furylacrolein, which will condense with acetone to form furylacroleinacetone (reaction 19).

The presence of the conjugated system in the side chain suggests interesting resin possibilities for this compound. Excess of acetaldehyde leads to the formation of a polymer furyl polyene aldehyde (reaction 20).

β-Furylacrylic acid may be obtained by three routes, namely, via ethyl β-furylacrylate, ethyl furfural malonate, and directly by acetylation and dehydration (reaction 21).

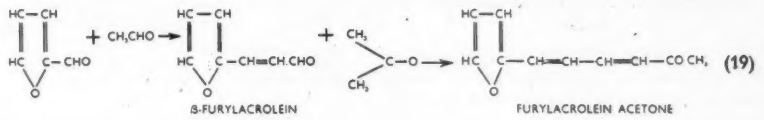
Apart from the fact that β-furylacrylic acid is a substituted acrylic acid and should, therefore, have the resin-forming properties of that acid, it is interesting because it will lose CO_2 to form vinyl furan, the furan analogue of styrene (reaction 22).

These reactions serve to show the inherent possibilities of furfuraldehyde as a raw material for the plastics industry.

Furfuraldehyde Resins

The reactivity of furfuraldehyde as an alternative to formaldehyde is well known, and the following descriptions of resin-forming reactions are typical.

(i) *Phenolic Resins* (acid catalysts).—One hundred parts of phenol, 15 to 40 parts of furfuraldehyde and 5-10 parts of hydrochloric acid are mixed together and warmed to promote the strongly exothermic reaction. The temperature is maintained for one hour at about 95 degrees C., then heated at 165 degrees



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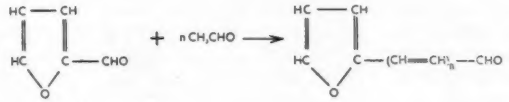

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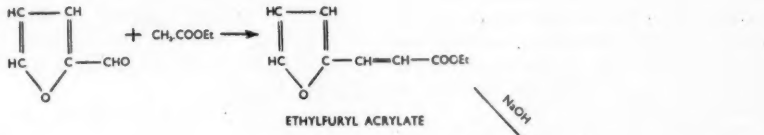

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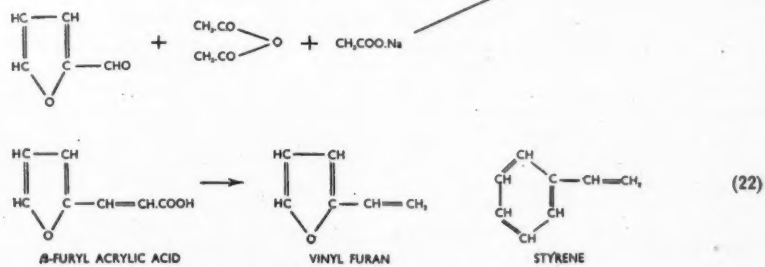


(22)

C. to remove unreacted materials. Excess of phenol is removed in vacuo or by steam distillation. The fusible resin resulting is used as the basis of moulding powders or for impregnation of laminates.

Phenolic Resins (alkaline catalyst).—One hundred parts of phenol and 75 parts of furfuraldehyde are mixed with 2 parts of potassium carbonate and heated under reflux condenser for two hours at 125-165 degrees C. The excess of reactants is removed by distillation and the resin may be mixed with fillers in the normal fashion, using hydrofuramide as a curing agent.

(ii) *Non-phenolic Resins* (Urea).—One hundred parts of urea, 300 parts of furfuraldehyde and 4 parts of 26 per cent. aqueous ammonia are refluxed for two hours at a temperature of 105 degrees C. The excess of reactants is then removed at a temperature of 105-160 degrees C. to give a soluble resin, which may be used for moulding powders or for impregnation of laminates.

Characteristics of Furfuraldehyde Resins

Phenol-furfuraldehyde resins do not go through the B-stage, which is characteristic of phenol-formaldehyde resins; the ring structure (of the furan ring) inhibits gelation and allows the resins to maintain their flow properties over relatively long periods at temperatures just above the softening point. In injection moulding, therefore, the resins flow readily until the mould cavity is filled and remain fluid until the full pressure is reached, and cure rapidly when the curing temperature is attained. High dimensional accuracy and correct positioning of inserts is assured because of the absence of the intermediate rubbery gel stage.

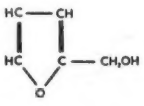
The furfuraldehyde resins are of value because of their high heat resistance, chemical inertness and resistance to water. Special grades of resin have particularly good electrical properties and find considerable application in the manufacture of laminated insulating boards.

Heat resistance enables moulders to use higher curing temperatures and lower mould cycles (35 seconds at 205 degrees C.) with less burning than is the case with the corresponding formaldehyde resins. The long curing time at temperatures just above those required to induce plasticity enables furfuraldehyde resins to be kept plastic in reservoirs for injection moulding without the troubles due to pre-curing which are normally encountered in the injection moulding of thermosetting resins. Colour possibilities are limited to dark shades, but polish and appearance are both excellent.

Furfuryl Alcohol

Furfuryl alcohol (23) is a colourless liquid, boiling point 171 degrees C., specific gravity 20 degrees C./4 degrees C. 1.130.

There are two main methods of preparing this alcohol: (i) By the Canizarro reaction, and (ii) by hydrogenation of furfuraldehyde in the presence of a nickel catalyst, this being the industrial method at present employed.



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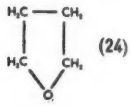


(24)

Furfuryl alcohol will condense with a number of materials, e.g., formaldehyde or phenol, to form useful resins. The alcohol also polymerizes in the presence of mineral acid to form a black resin. With phosphoric acid, the reaction may be controlled to yield a syrupy resin, which afterwards sets to an infusible material. Articles sprayed or impregnated with furfuryl alcohol may be treated with acid to polymerize the alcohol in situ.

The alcohol is a useful solvent, since it will dissolve cellulose nitrate, coumarone resins, ester gum and certain natural resins, such as sandarac, mastic, kauri and shellac. The resinification with acid should make it of interest in the formulation of "solvent-less" varnishes.

Tetrahydrofuran

Tetrahydrofuran (24) is a colourless liquid, boiling point 64-65 degrees C., specific gravity 20 degrees C./4 degrees C. 0.889. The material is miscible in all proportions with water and forms a constant boiling mixture of 95 per cent. tetrahydrofuran and 5 per cent. water, boiling at 63 degrees C. Tetrahydrofuran is an outstanding solvent and will dissolve many substances which are normally regarded as extremely difficult, e.g., cellulose triacetate. It is one of the best-known solvents for polyvinyl chloride.

The many reactions undergone by furfuraldehyde and its derivatives, the vast potential availability of them from hitherto waste materials, and the nature of the chemical reactions make these materials of peculiar interest to the plastics industry.

The Index to Vol. 10 of "Plastics" has now been published, and copies are obtainable from Temple Press, Ltd., Bowling Green Lane, London, E.C.1, price 7d. each post free.

Acetylated Cotton as Filler for Phenolic Moulding Powders (contd.)

By E. E. Halls

BRITISH Patent 280,493, which is due to Chemische Fabrik, 1928, covers the process of acetylation of threads. It appears to be designed to cover a method for rendering material resistant to dyeing with substantive dyestuffs, and is titled "Process for the Preparation of Effect Threads." It refers to other processes known at the time for the same purpose, but having inherent drawbacks. The fact that the particular product produced by the invention is an acetylated cellulose and that the properties conferred to the thread thereby would have important repercussions in other directions, namely, electrical applications, is beside the point. Nevertheless, it is significant that the product of the other processes, or at least of some of them, would not have served the same purpose; i.e., they would in all probability have been unsuitable electrically.

One of these processes comprised a first stage of alkalizing the cellulose and a second stage of esterifying the alkali cellulose with a solution of an acid chloride in an indifferent solvent. Carboxylic- and sulphonic-acid chlorides were employed in this process. Disadvantages are associated with the two processes involved and the use of organic solvents which cause plant complications.

The patent points out that these objections are overcome by using acetic anhydride for the esterification and thus enabling the process to be completed in a single operation without structural alteration in the fibre, mono- and di-acetyl esters being formed.

Again, reference is made to British Patent 5016/1907, in which cellulose is impregnated with an acetylation mixture consisting of acetic anhydride, acetic acid and a salt-like catalyst. It is then squeezed to a certain weight limit and afterwards acetylated by raising the temperature of the mixture in a closed space. The equipment entailed is complicated and the resultant fibres are irregularly acetylized. This is due to uneven spread of the acetylation mixture, either in the squeezing process or in the heating operation.

There is also reference to German Patent 347,130, in which cellulose is impregnated with a catalyst, and subsequently acetylated to partial esterification by exposure to the vapours from acetic anhydride boiling under reduced pressure. Again the plant is complicated, and there are practical difficulties due to catalyst being scrubbed out of some parts of the charge by condensing acetic-anhydride vapours and an increase in the catalyst content thereby in other portions.

Other processes referred to include the catalysation and acetylation in the same mixture, but they use only weak catalysts with correspondingly higher temperatures. For example, sodium acetate at 140 degrees C., heavy-metal salts of organic acids, such as zinc acetate, at 70-75 degrees C. (Ger. Pat. 380,994) are cited. Acetylation is slow, despite the elevated temperatures, and tendering of the fibres is inevitable.

A common feature of these process attempts is the prevention of the higher acetylation of the fibre and of the dissolution of the product in the acetylation mixture; hence the reason for carrying out the process in vapour or using only weak catalysts, it being assumed that it was not possible to produce the mono- or di-acetyl ester directly by inserting the cellulose in the acetylation mixture containing catalysts, as is the practice for the tri-acetyl cellulose product. This was based on the theory that the outside layers

of the fibre would become completely converted to tri-acetate, which would dissolve and expose new layers of cellulose to attack; this would proceed until the whole of the fibre had dissolved. This was found to be incorrect and British Patent 280,943 covers the acetylation of cellulous fibre to the mono- or di-acetyl derivative in the one bath, including catalysts. For this, it is necessary to control the reaction from the composition of the mixture and the working temperature. The acetylation must of necessity be slower than for the tri-acetate, 20 hours or more being cited. It can be carried out without loss of cellulose and with maintenance of the form, strength and elasticity of the original fibre. These lower acetylation products are first produced and are insoluble in the reaction mixture.

It is claimed that cellulose in any form, loose material, yarn and fabric, dried or wet, raw, bleached or dyed, can be processed in this manner. The product is removed from the reaction mixture at the completion of the degree of acetylation desired and surplus acetylation liquid is removed by squeezing, pressing or hydro-extracting. The acetylated fibre is washed thoroughly with water to remove acid and is dried. The acetylation mixture, including that recovered by pressing from the product, can be used over and over again with, of course, appropriate make-up of acetic anhydride and catalyst to replace the portion consumed.

Any of the catalysts used for the tri-acetylation are said to be suitable for this process, with the reservation that, in the case of very strongly active catalysts, the concentration must be appropriately reduced to obtain even treatment. The process is claimed to be simple, to be capable of operating at room temperature and to give perfectly uniform results.

Examples are given to illustrate the process, viz.:—

(1) One kg. of loose cotton is placed into an acetylation mixture of 3 kg. of acetic anhydride, 5 kg. of glacial acetic acid, and 2.5 kg. of sulphuric acid, contained in a closed earthenware vessel, so that the fibres are completely covered by the liquid. Acetylation proceeds at about 15 degrees C. and a test is made for completion of reaction in 48 hours. The fibre is then removed, pressed to expel liquid, washed and dried. (In this reaction the sulphuric acid can be replaced by any of the other catalysts normally used for the tri-acetate, e.g., halogen acids, nitric acid, phosphoric acid, sulpho-acetic acid, etc.)

(2) One kg. of bleached cotton yarn is immersed for 24 hours at 25 degrees C. in a mixture of 4 kg. of acetic anhydride, 4 kg. of glacial acetic acid, and 0.8 kg. of zinc chloride. The product is removed, surplus liquor removed by hydro-extraction and the yarn washed and dried.

British Patents 306,877 and 324,680, of the same company, deal with the dyeing of these mono- and di-acetylated fibres.

The acetylated cellulose fibrous materials have, of course, been known for many years, and the acetylated cottons, under the proprietary name of "cotopa," have been exploited very successfully for electrical insulation for some considerable time. The properties of this class of material were dealt with very completely by A. A. New, under the title of "Esterfied Fibrous Insulating Materials," in "Electrical Communication," 1935. This article gives the process for making acetylated cotton as follows:—

The raw cotton is first cleaned with 1 per cent. caustic-soda solution by Kier boiling in an enclosed vessel with the minimum of free-air space. The treatment period is about 10 hours at a minimum pressure of 20 lb./sq. in. Bleaching follows by immersion in a solution of bleaching powder or sodium hypochlorite containing not more than 2 to 3 gm. of available chlorine per litre. The cotton is then transferred to a dilute solution of hydrochloric acid, and the chlorine thus set free, bleaches the material and

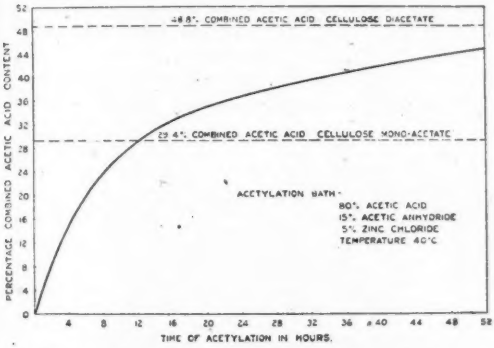

38.8% COMBINED ACETIC ACID CELLULOSE DIACETATE
29.4% COMBINED ACETIC ACID CELLULOSE MONO-ACETATE
ACETYLATION BATH -
80% ACETIC ACID
15% ACETIC ANHYDRIDE
5% ZINC CHLORIDE
TEMPERATURE 40°C
PERCENTAGE COMBINED ACETIC ACID CONTENT
TIME OF ACETYLATION IN HOURS.

Fig. 1.—Relation of combined acetic acid content to time of acetylation.

removes the non-cellulosic impurities. The preliminary purification is completed by thorough water-washing.

For the acetylation operation proper, the cotton may be in any suitable form, such as yarns, hanks, cops. The esterification is achieved by immersion in a bath composed of acetic anhydride, a dehydrating catalyst, and glacial acetic acid as

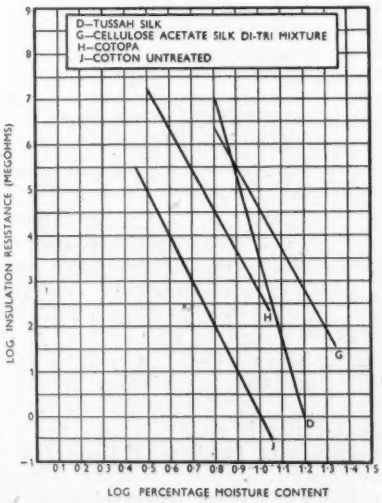


Fig. 2.—Insulation resistance of textiles as a function of their mixture content.

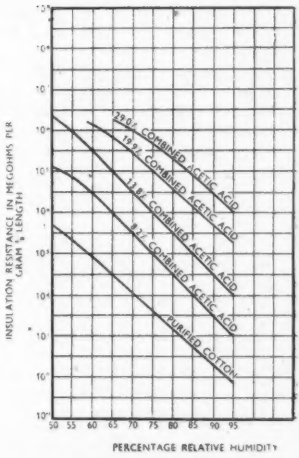

29.0% COMBINED ACETIC ACID
19.9% COMBINED ACETIC ACID
13.8% COMBINED ACETIC ACID
9.1% COMBINED ACETIC ACID
PURIFIED COTTON
INSULATION RESISTANCE IN MEGOHMS PER CRAIN LENGTH
PERCENTAGE RELATIVE HUMIDITY

Fig. 3.—Relation of insulation resistance (with increasing degrees of acetylation) to relative humidity.

diluent. The immersion is continued to give acetylation to the extent of 25 to 30 per cent., expressed as combined acetic acid. Thorough water-washing to remove the acetylating agents completely must follow. The following acetylation mixture is cited and stated to achieve satisfactory acetylation of cotton fibres to the mono-acetate stage in 15 hours at 40 degrees C.:—

> Acetic anhydride, 15 per cent.; anhydrous zinc chloride, 5 per cent.; glacial acetic acid, 80 per cent.

The acetylated cotton is given a further processing to develop its optimum properties, by which it loses the ability to swell in water, and to take direct dyes from a dye bath, and it improves with respect to electrical insulation resistance. Drying for several hours at 100 to 110 degrees C., or subjection to high-pressure steam for a short period, effect this stabilization.

The acetylation process can be successfully carried out at lower temperature with correspondingly longer time. Higher temperatures increase the rate of reaction, but control is more difficult because of a

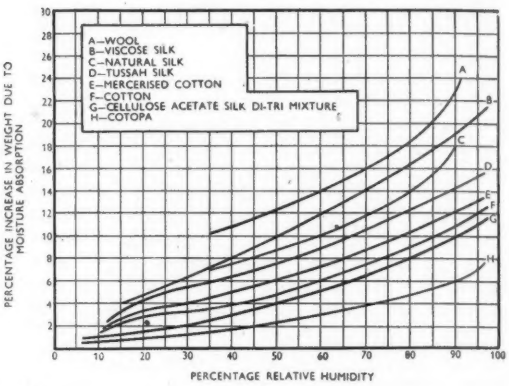
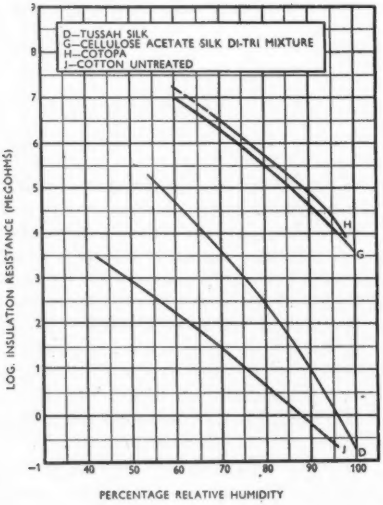


Fig. 4 (right).—Relation of moisture absorption of various textiles to relative humidity of atmosphere where exposed.

Fig. 5 (below).—Relation of insulation resistance of textiles to relative humidity.



tendency to convert to tri-acetate on the outer layers of the fibre. For the progress of acetylation at 40 degrees C., New gives the curve reproduced in Fig. 1.

It is apt and useful to include some data appertaining to the water absorption and insulation resistance values of acetylated cotton in comparison with those for other textile fibres. To this end, the following graphical data are reproduced from New's work.

Fig. 2 shows, on a double logarithmic scale, the relationship between water content and electrical insulation resistance for a number of textile yarns. From this curve the marked superiority of acetylated cotton over ordinary cotton is clearly apparent.

Fig. 3 connects insulation resistance with relative humidity for cotton acetylated to different extents and shows the progressive improvement with extended esterification.

Fig. 4 portrays moisture absorption as related to humidity of the atmosphere in which exposed. Acetylated cotton is by far the best of the eight textile fibres represented.

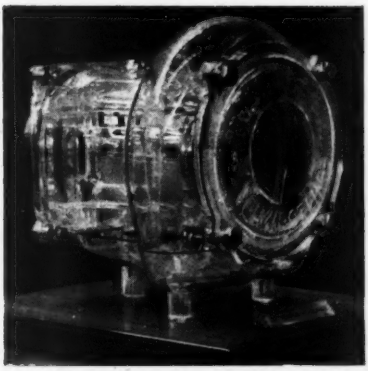
Fig. 5 plots insulation resistance on a logarithmic scale against humidity, and places acetylated cotton on the top.

These are typical data selected from extensive information that demonstrates the usefulness of acetylated cotton for purposes of electrical insulation. Experience shows that these advantages of acetylated cotton over plain cotton are retained by equipments after impregnation treatments with wax, bitumen, varnish, and the like. Corresponding special features are, therefore, to be expected from phenolic-resin mouldings having acetylated cotton as filler, as compared with those mouldings which have fillers of ordinary cotton, paper or wood flour.

Plastics at Hanover Trade Fair

THOSE who knew industrial Germany before the war expected a most interesting exhibition of plastic goods at the first German Export Fair, held at Hanover, September 1-4. The plastics industry, already developed in advance of the British and French industries before 1939, must have received a tremendous development during the war in a country which was so much lacking in raw materials, and therefore interested in "substitutes," which in German was the legitimate name of plastics., i.e., ersatzstoffe, until there came the better-sounding names of "austauschstoffe," "kunststoffe" and "kunstharze." Therefore so much greater was the disappointment in finding that the show was not up to expectations from the point of view of the plastics industry, especially in contrast with applications of light metals.

A possible explanation for this discrepancy is to be found in the raw material supply, which will, for years to come, apparently remain so scarce and may not even be sufficient for the most urgent domestic uses, in view of which little encouragement seems to have been given to this particular industry. Yet from the point of view of raw materials, the light metals seem to be in a much more precarious position, as the production of aluminium and magnesium in future will not be allowed and the necessary ingots will have to be imported. On the other hand, the German plastics industry will have home materials, even if they are in short supply.



Transparent methyl methacrylate was used for this model of the "Isothermos" railway truck bearing (Knorrbremse G.m.b.H.)

These findings are the more surprising as the German plastics journal, "Kunststoffe," again in the hands of its former editor, Dr. Escales, shows a very high standard, and in almost every issue brings forward new research reports which prove the earnest endeavour of the German technologists to regain contact with the outer world. It is additionally of interest that "Kunststoffe" was one of the first technical journals to be again published in Germany since the occupation, the first post-war issue appearing in July, 1946.

A small exposure meter shown by Addiphot (H. G. Lange) was in the form of a slide rule, 2⅝ ins. by 1$\frac{5}{16}$ in. by $\frac{1}{16}$ in., and consisted of a phenolic plate cut with a dovetail to take a small slide of white urea resin. The phenolic plate carries glass windows of varying degrees of darkness ranging from 1 to 7; through these windows the object is observed, noting the last discernible light indicator figure with the slide held at reading distance to the eye. The slide is adjusted for sensitivity of film or plate, and the co-ordinated aperture and exposure times are then read direct.

Another article of some present-day utility was a pocket sundial, the invention of Dr. Rueter, to compensate for the shortage of pocket and wrist watches. This novelty had a phenolic housing and a transparent plastics cover. A magnetic system was incorporated to allow the dial to adjust itself in a north-south direction on pressing a button. The dial, of course, is held horizontally when the release lever is to be operated. It is

claimed to be astronomically correct, and special types are supplied for different countries, the makers being Lee and Ney of Bremen.

Moulded parts made with phenolic and amino-resins, as also others based on "Plexigum," were exhibited by Fr. Mueller, Brackwede (Westphalia). Tube caps and covers in a variety of types and sizes were shown by Günther-Wagner, Hanover. E. Rosenthal has developed an impressive variety in sinter-iron and other substitute bearings, including small steel bearings in which the journal is covered with a thin film of phenolic resin. These bearings find applications at very slow speeds, one interesting instance being in artificial limbs for the avoidance of squeaking. The firm of Gablanz, now established in the Germany boundaries, has developed a type of cheap jewellery, using moulded plastic plaques in mottled colours, which are ornamented by polished brass parts of simple form, such as thin brass tubes which have been obliquely cut.

Some use has been made of transparent plastics for model and demonstration purposes. The accompanying illustration shows a "Perspex" model of the Isothermos railway truck bearing, exhibited by Knorrbremse G.m.b.H. For their new aluminium tap with straight-line flow for the water and sealing by circular rubber ring, the Goettinger Metallwerke used a working model made of transparent plastic. So impressive was this model that one was tempted to ask if the tap could not be made better wholly of non-corrosive plastic.

STROUD TECHNICAL COLLEGE.—A special course of eight lectures has been arranged to meet the needs of those who require a comprehensive survey of the plastics industry, but who are not able to take the two-year course leading to the City and Guilds examination. The lectures will be given on successive Tuesdays from October 21 to December 9 inclusive at 7.15 p.m. in the Technical College, Lansdown, Stroud. Each lecture will be followed by discussions. Admission will be by tickets, covering the whole course, at a fee of 21s. The syllabus is as follows:—

Oct. 21.—Historical development and introduction (Dr. C. A. Redfarn).

Oct. 28.—The natural and cellulosic plastic materials (Mr. J. H. Collins).

Nov. 4.—The synthetic thermoplastic materials (Mr. J. H. Collins).

Nov. 11.—Thermosetting plastic materials and plastic machinery (M. J. L. Daniels).

Nov. 18.—The moulding of plastics (Mr. W. D. Davies, works manager, Streetly Manufacturing Co., Ltd.).

Nov. 25.—Plastics in the electrical and engineering industries (Mr. N. G. McCullagh, The New Insulation Co. Ltd., Gloucester).

Dec. 2.—Plastics and textiles (Mr. E. V. Giles, Hunt and Winterbotham, Ltd., Cam, Glos.).

Dec. 9.—The future of the plastics industry—technical development and education (Dr. V. E. Yarsley)

MARBERRY PRODUCTS, LTD., who are engaged in the casting of phenol-formaldehyde resins have just completed negotiations for the purchase of Slazenger's factory at Hurstpierpoint, Sussex, to which they are turning over all their production work. An extensive research section is to be built up in the former premises. Although incorporated only in April of this year, Marberry Products, Ltd., are already engaged in fulfilling extensive contracts for the Swiss and South American markets.

CELLULOSE ACETATE PLASTICS

(Continued from page 531)

after separation. Owing to the small amount involved, carbon dioxide free water is used, and a careful blank estimation carried out on all reagents.

The stability to light is normally excellent, although slight surface degradation occurs on prolonged exposure to the lower wavelengths.

(To be continued.)

REFERENCES

(1) *Yarsley, Synthetic Resins and Allied Plastics (Morrell). Oxford,* 1943 (*pages* 81-82). **(2)** *Fordyce, U.S. Pat.* 2,129,052. **(3)** "*Hercules Cellulose Acetate,*" (*Hercules Powder Co. Ltd.*). **(4)** *Doree, Methods of Cellulose Chemistry. Chapman and Hall,* 1947.

LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired.

Goods for Australian Market

Sir,—We draw your attention to the article "Light on Black Diamonds" in the July issue of "Plastics," which we found most interesting. We have since written to Ernest and Henry, Ltd., of Bishop Auckland, and have requested of them exclusive representation of their goods throughout Australia.

We are particularly interested in either representing or carrying stocks of a number of varieties of plastic buttons and dress accessories, and would be very grateful if you would be so kind as to refer our interest of the trades mentioned to other manufacturers interested in our country as a market. We have a complete coverage throughout the Commonwealth for any type of buttons, dress accessories, and general fancy goods.

JACKS AND KERSHAW.
327 Collins Street,
Melbourne, C.1.

Sources of Information

Sir,—We notice with interest in "Plastics" (August, 1947, p. 413) some reference to the crazing of plastic dentures. Being particularly anxious to obtain the "Technical News Bulletin" issued by the National Bureau of Standards, we shall be grateful if you can let us know the address of this bureau or of publishers to whom we might apply for a copy of the bulletin mentioned.

RICHARD LORD AND CO., LTD.
Blackburn.

[EDITOR'S NOTE: The address of the National Bureau of Standards is Washington, D.C., U.S.A. Publications of the Bureau may be seen at the Library of the Patent Office in London, and also at libraries maintained by some of the larger industrial cities throughout England, as at Manchester, Birmingham and Sheffield. Where difficulty is experienced in consulting such publications, the larger technical colleges will often courteously extend help from their own reference library facilities.]

Luminous Ash-trays

Sir,—We believe that luminous plastic ash-trays for cinemas has been suggested. Have you any information regarding production? B.C.C., LTD.

[EDITOR'S NOTE: About the year 1940, when the blackout and military requirements demanded it, much publicity was given to the production of luminous plastic objects such as indicators, dials and the like. The photograph reproduced here shows a luminous ash-tray moulded from urea-resin containing a luminous constituent. It was received from a moulding concern,

but we retain no trace of the name. As to its success under practical conditions we have no information. Our own criticisms are that such ash-trays require "revivifying" under light and that in the presence of foul air and cigarette-ash and smoke, the luminous filler becomes "poisoned" and power of luminescence diminishes.]

Plastic Coating for Valves

Sir,—We are interesting ourselves in the coating of various parts of valves and allied products, which are intended for use at power stations and in similar situations, i.e., under cover. We are contacting you in the hope that you can furnish us with the names of firms who would

supply us with the plastic finish we desire. The colour we should require at this stage will be black, applied by a simple process, for instance, dipping the parts into a lacquer followed by a low temperature stoving or anneal.

The matter is very much in the experimental stage and it is possible that the solution lies in a low temperature stoving enamel, but we hope that a very durable, thick and better finished preparation can be obtained in the plastics industry. We would greatly appreciate your co-operation in this problem.

J. BLAKEBOROUGH AND SONS, LTD.
Brighouse, Yorks.

P.V.C. Adhesion

Sir,—I am using p.v.c to make up certain units and am anxious to find a suitable adhesive. Can you give any information on this subject?

Leeds. L. T. SAUNDERS.

[EDITOR'S NOTE: Adhesives can be obtained from the manufacturers. For joining two pieces of p.v.c. a 10 to 20 per cent. solution of chlorinated p.v.c. (that is polyvinyl chloride further chlorinated) in methylene chloride, or a similar solution in a mixture of methylene chloride and cyclohexanone. A special non-hardening adhesive of a different type for cementing p.v.c. floorcloth to concrete and wood is also available.]

Plastic Coating

Sir,—We are desirous of getting in touch with the manufacturers of a plastic coating which could be sprayed on metal parts and then heat-dried, either in ovens or by infra-red treatment, in order to provide a smooth, polished surface.

The only material of this nature of which we have any knowledge is a "lacquer" based on phenolics, but this material suffers from the disadvantage that it cracks very easily if heavy weights are dropped on it, and we are anxious to find a more flexible coating which will not injure in this way.

It would be appreciated if you could put us in touch with manufacturers of a plastic coating of this nature.

CEREBOS, LTD.
Greatham, Billingham, Co. Durham.

Menthol Containers

Sir,—We enclose samples of two plastic cases, as used for holding menthol, and would be glad to know who would under-

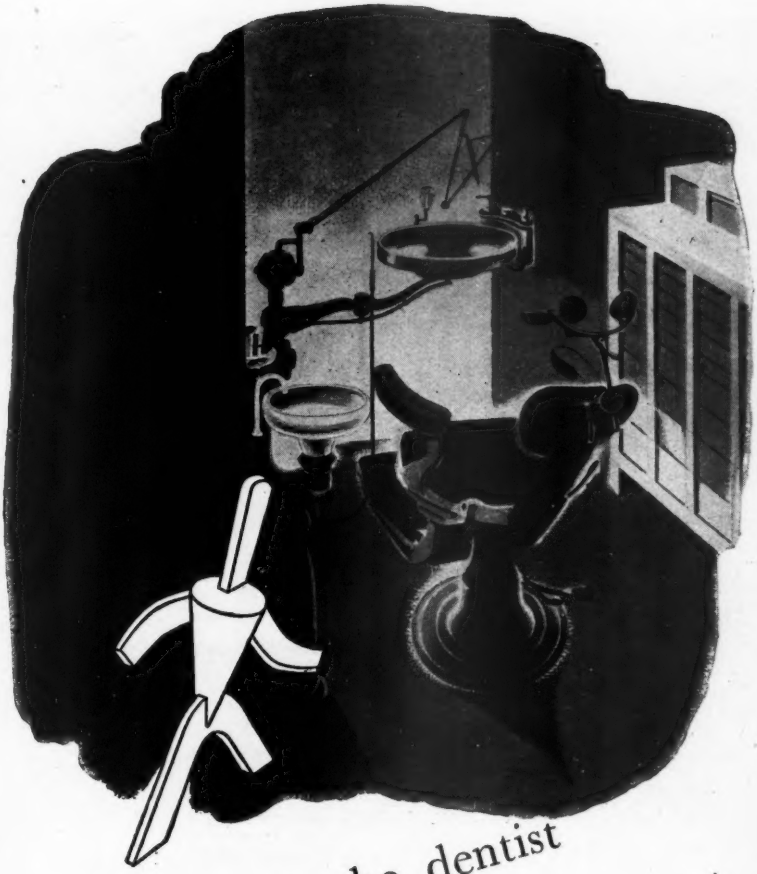
take the manufacture of articles of this description. We need them for export purposes.

HENRY W. BUSH AND CO., LTD.
34, North End,
Croydon.

Resin Impregnated Pulp

Sir,—We read with interest the articles on "Thermosetting Mouldings from Resin Impregnated Pulp" published in the September and October issues of "Plastics," and would like to follow up this process with a view to applying it in book or ledger cover manufacture. The plant required is fairly extensive, and we are wondering if you would be able to put us in touch with any firm working this process, with a view to obtaining samples and possibly trial materials for initial experiments. KALAMAZOO, LTD.
Northfield, Birmingham, 31.

BRITISH INDUSTRIES FAIR, 1948, will be held in London and Birmingham from May 3-14. Forms of application for exhibiting space will shortly be sent to manufacturers known to be interested in the Fair. On receipt of the form, intending exhibitors are urged to notify promptly their requirements in order to facilitate the early allotment of space



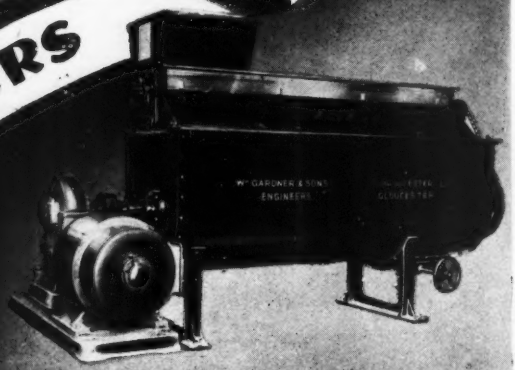
Plastics go to the dentist

Acrylic plastics' first appointment with the dentist was made by I.C.I. in 1935. In the familiar form of "Kallodent" and "Kallodentine" they are now universally used. Their success in this field is yet another example of the versatility of plastics.

ICI

P.230

PERFECTLY MIXED POWDERS



with

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Patent 'Rapid'

SIFTERS & MIXERS · MIXERS

Designed for accurate mixing and blending of fine powders, the Gardner Patent "Rapid" Sifter-Mixers and Mixers produce intimately mixed batches of powders quickly and efficiently. These machines are world famous for their long continuous trouble-free service.

Gardners have many machines designed for the Plastic Industry: Special Grinders for reducing cellulose acetate scrap from moulds whilst the batch is operating; Sieving and Dressing Plant; Elevating and Feeding Plant, etc. Send for fully illustrated catalogue now.

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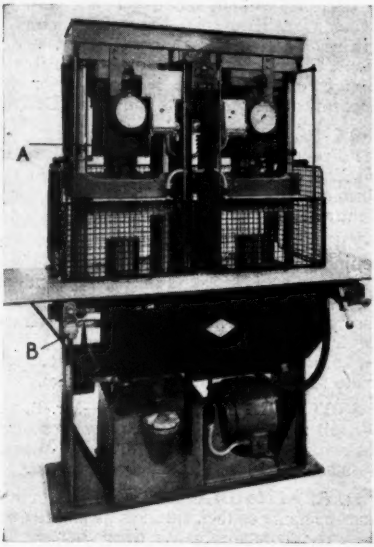
PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes



REFINEMENTS IN PRESSES.—The 25-ton dual downstroke unit by Finney Presses, Ltd., Birmingham, here illustrated, has several unique features of recent development, shown for the first time at the 1947 British Industries Fair. The press is provided with rubber piping throughout. It has a new patent two-speed ram, which gives a rapid approach of moving platen, and an automatic change-over to pressure when the platen meets resistance. This change-over takes place at approximately 2 to 3 tons. Instantaneous ease of movement for the moving platen is obtained by an hydraulic push-button control valve. In the accompanying illustration the two-speed ram is indicated at A, and the push-button control valve at B.

A special feature of this machine is the loading table mounted at tool level, so that portable tools may be inserted or withdrawn from press at the level of the hotplate. The hotplates are of the Finney standard patent pattern, which have proved themselves in service to have very high thermal efficiency.

The alignment and manufacture of this machine has been carried out to very fine limits so that the platen has a parallelity of 0.002 thou. across corners. The speed of approach of platen is 5 inches per second, and the speed of return approximately 7 inches per second. The speed for moulding is ¼ inch per second.

On the quick or approach stroke, the main cylinder is prefilled by a low-pressure boost pump fitted to the high-pressure pump, which always maintains a supply of oil in cylinder on the quick stroke. Another feature is the application of specially designed synthetic rubber packings on the main ram. Special interlock guards are provided to meet Home Office requirements.

DIELECTRIC PREHEATERS of the Ferranti-Wild-Barfield type for the plastic moulding shop are described in catalogue RF/D.447 recently issued by Wild-Barfield Electric Furnaces, Ltd., of Elecfurn Works, Watford, Herts. These heaters are used in connection with the preheating of both preform and powders. An outstanding feature of model 4 B.D.P. is the provision of an automatic load control system. The incorporation of such a system enables the maximum power to be applied in the initial stages of heating, and notwithstanding any change in the electrical characteristics of the material during heating, the maximum power output to preform or powder is automatically maintained. A special arrangement of switching on the mains contractor eliminates the current surge which would otherwise occur at the moment of switching on. The equipment will provide 2 kW of radio frequency energy at a frequency of 28 megacycles per second. This is equivalent to a heat energy supply at the rate of 6,824 B.Th.U. per hour, and due to the automatic load control the equipment will heat approximately 40 oz. of general-purpose phenolic moulding material to 100 degrees C. in two minutes.

ORGANIC CHEMICALS. — Available data on a range of chemicals manufactured by Robinson Brothers, Ltd., Ryders Green, West Bromwich, is given in list recently issued. This company is always glad to consider inquiries for supplies of organic

cnemicals which are not in current manufacture. In the present list we notice various amine derivatives of particular interest to the rubber industry as vulcanization accelerators; zinc dimethyl dithiocarbamate, finding use as a waterproofing agent, is included among other products which are apparently of very recent introduction.

KEY INDUSTRIES DUTY.—The Treasury have made an Order under Section 10 of the Finance Act, 1926, exempting normal butyric acid, and cellulose acetate from Key Industry Duty for the period beginning September 18, 1947, and ending December 31, 1947. The Order is entitled "The Safeguarding of Industries" (Exemption) (No. 6) Order, 1947, and is published as Statutory Rules and Orders, 1947, No. 1960; copies (price 1d.) obtainable direct from H.M. Stationery Office, Kingsway, London, W.C.2.

P.V.C. SHEETING PRICES.—The Board of Trade, in consultation with the Central Price Regulation Committee, have made an Order amending the P.V.C. Sheeting (Maximum Prices) Order, 1946. Manufacturers who print p.v.c. sheeting which they themselves did not calender may now take a margin of 14.29 per cent. on cost (12½ per cent. on returns). The costs of "processing)" (defined as embossing, moulding, pressing or perforating the surface of the sheeting or any other process, except printing, which changes the appearance of the surface) may now be taken into account in calculating the manufacturer's maximum price of the sheeting. The Order came into effect on September 29, 1947. Copies (S.R. and O. 1947 No. 2059) are obtainable from H.M. Stationery Office (price 1d.).

D.S.I.R. SCOTTISH OFFICE.—The Department of Scientific and Industrial Research has opened a Scottish Office at 18, Melville Street, Edinburgh. Among other functions this office will encourage the prosecution of research by industry and increase the effectiveness of the contribution which existing Government research establishments make to Scottish industry. It will provide means of encouraging contacts between Scottish firms, the D.S.I.R. Laboratories and the Research Associations and make more readily available in Scotland a large volume of scientific information already existing within the D.S.I.R. organization. The office will be in charge of Dr. H. Buckley.

LEICESTER COLLEGE OF ART is now fully equipped for training in advanced industrial design. The machinery which has been installed includes the latest model Turner plastics press. Only students with a good basic training in either art, design or engineering will be admitted to the courses, which are of two types—one of six months' intensive training and one longer. Mr. N. R. G. Poynton, who studied at the Royal College of Art, will be responsible for the department of Advanced Industrial Design.

BX PLASTICS, LTD.—The address of the Birmingham office has now been changed to: Empire House, 159 Gt. Charles Street, Birmingham, 3. Telephone: Birmingham Central 2365.

ZIRCONAL, LTD., has been formed in conjunction with Silicon (Organic) Developments, Ltd., 11 Cavendish Place, London, W.1., as a production unit for the manufacture of synthetic Mullite and zircon refractory compounds, using the "Silester" bonding process. They are fully equipped to make semi-permanent moulds and dies.

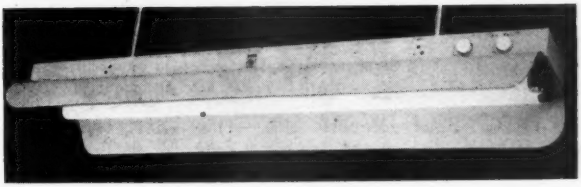
SCOTTISH PLASTICS LTD.—Mr. B. C. Westall and Mr. J. Eerdmans have resigned their directorships and Mr. C. Milton Marshall has been elected to the board.

D. R. ALDRIDGE AND CO. announce that the name of their business as plastic and light metal engineers has been changed to Zinnie Products; the address is 135 High Street, Bromley, Kent.

MR. GEORGE FEJER, M.S.I.A., Dipl. Arch. Fed. Tech. Univ., Zurich, is now in practice again as a consultant designer, having severed his connection with Uni-Seco Structures, Ltd. He has recently returned from a visit to Switzerland, where he has made himself acquainted with new trends in design and development and has also explored certain export possibilities. His present address is 70, Ormonde Court, Upper Richmond Road, London, S.W.15. (Tel: Putney 4729.)

MR. R. H. WINDSOR, of Technical Machines and Accessories, London, was taken ill at his office and died within a few hours on September 2, at the age of 50. He was sole proprietor of T.M.A., and one of the pioneers in the supply of injection moulding machines in this country, having been the representative of Eckert and Ziegler from 1937. It was on the outbreak of the war that he commenced manufacturing this type of machine, and eventually developed the T.M.A. hydraulic models.

New Productions from the Moulding Shops



"Perspex" v. Enamelled Steel

Opal "Perspex" is used as alternative to enamelled steel for the detachable reflectors of a new series of fluorescent industrial lighting fittings by Philips Electrical, Ltd., Shaftesbury Avenue, London, W.C.2. Our illustration shows one of these fittings illuminated by two 40-watt tubular lamps; the overall length is 4 ft. 1 in., thickness of "Perspex" $\frac{1}{8}$ in.

It has been found that "Perspex" offers many advantages over the usual enamelled steel as a reflector for fluorescent tubular lighting. Its most useful property is the fact that it is translucent. This means that the light source can be placed immediately over the fitting if desired, with resultant complete diffusion of light. If the tube is placed below the fitting, then the plastic allows the light to penetrate upwards, thus eliminating the "tunnel" effect due to the casting of a hard shadow on the ceiling in the case of the metal fitting. The plastic, also, is much lighter than enamelled steel, and by its use the total weight of the fitting can be much reduced.

Noiseless Cistern

Shires and Co. (London), Ltd., of Normans Buildings, Central Street, E.C.1, were fully aware of the shortcomings of the average flushing cistern, and carried out investigations to ensure absolute reliability for the syphon. From that beginning came an entirely new type of cistern, which, while conforming to British Standard Specification 1125, claims an advance on existing patterns. This noiseless low-level cistern is compression moulded by United Ebonite and Lorival, Ltd., using a mixture of pitch with disintegrated asbestos fibre. It is attractive in appearance, immune against corrosion, and, indeed, almost indestructible.

Toy Diver

This ingenious toy, shaped and painted to represent a diver, was exhibited at the 1947 British Industries Fair by Dixon Plastics, Ltd., of Earls Barton, Northampton. It is of blown cellulose acetate and measures about five inches in height. In action, the diver sinks below the surface of the water by virtue of its weight, due to lead at the feet, water slowly entering the body through a small hole. The lead weight keeps the

figure upright when it comes to rest on the "sea floor" at the bottom of a glass aquarium tank. To cause the diver to rise, you merely blow air in by way of a rubber tube which is attached, to expel the water which is present. The motion of the diver in sinking and in rising is characteristic of the real thing.

PLASTICS IN GERMANY

The New Target in Germany is the Science behind the Industries. The following are additional Notes from the Official Reports which can be obtained from H.M. Stationery Office.

F.I.A.T. Final Report 860.—This report covers the production of mono vinyl acetate by the vapour phase catalytic process in which acetic acid is added to acetylene under the catalytic effect of zinc acetate on carbon. A comparison of the operating process employed by the I.G. plant at Höchst and the Wacker plant at Burghausen is made. Apart from the distillation step the most fundamental difference between the two processes is in reactor design; Höchst employs the popular Fischer type converter, whereas Burghausen prefers a multitubular reactor with catalyst within the tubes. The preparation of the activated carbon employed in also described.

F.I.A.T. Final Report 861.—German efforts to produce a group of plasticizers for p.v.c., that would fit into German economics and still satisfy the demands of the applications, are reviewed. The report contains a theoretical discussion on plasticizer constitution, and details of manufacture of several important plasticizers, including diamyl phthalate, dicyclohexyl phthalate, Plastomoll TAH (diethylhexyl thiodihityric acid ester), dixylocarbonate, diisopropyl naphthalene, diphenoxy diethanol formal, and tetrachloro naphthalene.

F.I.A.T. Final Report 862—Details of the production of p.v.c. at Burghausen and Ludwigshafen, in this report, supplement the information given in C.I.O.S. Report No. 27-51 concerning plant at Schopau and Bitterfeld where large quantities of p.v.c. polymers were also made. The present report gives details of operation for the plant of Dr. Alexander Wacker, A.G., which produced p.v.c. by suspension polymerization as the main method, with a capacity of 300 tons per month. The bulk of the output at this plant was "Vinnol HH, H, and K," which contain no emulsifier; HH and H were used for manufacturing boot soles, cycle tyres, etc., while K was used as cable insulation. Four components normally made up the suspension system: monomer, water, catalyst and hydrophillic material, the monomer in this case being pure vinyl chloride, 99.8 per cent. produced by the HCl and C_2H_2 reaction. The water used for polymerization was purified either by distillation or by ion exchange. Benzoyl peroxide was the catalyst. The hydrophillic material for stabilizing the suspension was poly vinyl alcohol, or, more accurately, 85 per cent. hydrolized high viscosity poly vinyl acetate with a saponification number of 125.

F.I.A.T. Final Report 867.—This report covers the production at Burghausen of mono-vinyl chloride from anhydrous hydrogen chloride and acetylene, using a mercuric chloride (1 per cent.) promoted catalyst of barium chloride (30 per cent.) on activated carbon. Details of the preparation of the activated carbon are also included. This process has the advantage of long catalyst life with corresponding low mercury consumption. On the other hand, the process operates at low conversion and considerable accessory equipment is needed for the recovery of the product. Conversion at 100-180 degrees C. amounts to about 25 per cent. in a single pass. The converted gases are scrubbed with tetrachlorethylene to remove vinyl chloride. The gases are recycled and the vinyl choride is recovered from the trichlorethylene by distillation at elevated pressure. Two identical tanks of converter and accessory equipment are installed, but only one series of columns. The life of the catalyst is undetermined; one batch had operated for 8,000 hours when the unit

(*Continued on page 564*)

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 588,834. Application date: 21.8.44. Convention date (U.S.A.): 15.10.43. Accepted: 4.6.47.

Stabilization of Polyesters. To: The Resinous Products and Chemical Co.

Refers to the stabilization of Polyesters prepared according to B.P. 588,833.

B.P. 588,903. Application date: 9.3.45. Accepted: 5.6.47.

Improvements in or relating to High-frequency Power Measuring Systems. R. C. Robbins. To: Ministry of Supply.

B.P. 589,015. Application date: 15.3.45. Accepted: 9.6.47.

Improvements in the Manufacture of Styrene and Derivatives of Styrene. W. Hunter and W. H. Groombridge. To: British Celanese, Ltd.

Manufacture of styrene and styrene derivatives by heating phenyl methylcarbinol in the vapour phase under reduced pressure in the presence of a dehydration catalyst.

B.P. 589,065. Application date: 11.12.44. Accepted: 10.6.47.

Improvements in or relating to the Manufacture of Unsaturated Polymerization Products. J. R. Roland. To: E. I. du Pont de Nemours and Co.

Telomers produced by reacting aliphatic mono-olefinic hydrocarbons with a non-polymerizable unsaturated halogen containing organic compound at elevated temperatures and pressures in the presence of a catalyst for ethylene.

B.P. 589,072. Application date: 30.9.42. Convention date (U.S.A.): 1.8.41. Accepted: 11.6.47.

An improved Process for the Production of Ethyl Benzene. To: Standard Oil Development Co.

B.P. 589,167. Application date: 16.3.45. Accepted: 12.6.47.

Improvements in or relating to the Production of Fluorinated Derivatives of Aliphatic Hydrocarbons. W. B. Whalley. To: Imperial Chemical Industries, Ltd.

B.P. 589,197. Application date: 19.3.45. Convention date (U.S.A.): 20.3.44. Accepted: 12.6.47.

Production of Vinyl Fluoroacetates and of Polymers thereform. To: E. I. du Pont de Nemours and Co.

Production of vinyl fluoroacetate by reacting in the liquid phase a fluoroacetic acid with acetylene in the presence of an oxide and/or salt of mercury.

B.P. 589,220. Application date: 20.3.45. Accepted: 13.6.47.

Improvements relating to Printing Plates and Matrices. E. S. Hole.

Moulding of flexible thermosetting printing plates and matrices from unsized paper impregnated with a thermosetting mouldable resin. The impregnated paper is backed with a thick layer of vulcanizable material, and vulcanization of the latter is carried out simultaneously with moulding of the resin impregnated paper while taking an impression from the mould in the paper.

B.P. 589,221. Application date: 20.3.45. Accepted: 13.6.47.

Improvements relating to the Production of Curved Printing Plates from Thermosetting or Thermoplastic Material. E. S. Hole.

Relates to the production of printing plates for use in rotary printing presses. A curved matrix is placed in a concave platen and covered with one or more layers of sheet material impregnated with a synthetic resin, then a convex platen is superimposed and the moulding effected by heat and pressure.

B.P. 589,248. Application date: 9.11.44. Accepted: 16.6.47.

Improvements in or relating to the Preparation of Synthetic Rubber-like Materials. To: Standard Oil Development Co.

Production of Polymers or Copolymers by treating a soap emulsion of one or more conjugated diolefins with or without a copolymerizable hydrocarbon (acrylonitrile, methacrylanitrile or styrene) with an oxygen-liberating polymerization catalyst, coagulating the resulting latex with a sodium chloride brine, adding an alkali hydroxide to the slurry and separating the polymer or copolymer from the alkaline liquid.

B.P. 589,264. Application date: 21.3.45. Accepted: 16.6.47.

Improvements in or relating to the Production of Polymeric Materials. D. Brundrit and J. A. D. Hickson. To: Imperial Chemical Industries, Ltd.

Method of increasing the rate of polymerization of vinyl chloride in aqueous solution

by adding to the solution an emulsifying agent, a peroxide catalyst and a soluble copper salt (copper sulphate).

B.P. 589,245. Application date: 16.10.44. Convention date (U.S.A.): 12.6.44. Accepted: 16.6.47.

Method of Dyeing Cellulose Acetate and Compositions for use therein. To: Textron Incorporated.

Dyeing of Cellulose Acetate by treating it with an aqueous solution of an acid, basic or indigosol dye containing free acids, and an organic solvent (ethyl acetate, "Cellosolve," carbitol acetate, diacetone, alcohol, dioxane, butyl cellosolve, cellosolve acetate, acetnoyl acetone tetraethylene glycol, dimethyl ether glycol diformate, benzoyl cellosolve, etc.).

B.P. 589,265. Application date: 21.3.45. Convention date (U.S.A.): 25.3.44. Accepted: 16.6.47.

Process of Sealing Cellulose Ether Sheet Materials and Articles produced thereby. To: Sylvania Industrial Corporation.

Joining of sheets of alkali-soluble, water-soluble cellulose ether by applying an alkali solution to the cellulose surface and bringing the surface so treated in contact with another surface. Uses mentioned are the fabrication of tubes, containers, packagings, etc.

B.P. 589,287. Application date: 24.5.44 and 28.10.44. Accepted: 17.6.47.

Process for Providing Plastic Surfaces with Inlays. L. Rado.

B.P. 589,291. Application date: 28.7.44. Convention date (U.S.A.): 31.7.43. Accepted: 17.6.47.

Arrangements for Measuring High Frequency Electric Power. J. A. Frabutt. To: Standard Telephones and Cables, Ltd.

B.P. 589,293. Application date: 4.8.44. Convention date (U.S.A.): 6.8.43. Accepted: 17.6.47.

Production of Laminated Structures. The Honorary Advisory Council for Scientific and Industrial Research (Canada).

Laminated structure prepared by mixing acetylene black with urea-formaldehyde resin adhesive, applying the mixture to the laminæ, assembling the latter in a press and passing an electric current (110-220 volts) through to generate heat in order to set the assembly.

B.P. 589,331. Application date: 8.9.42. Accepted: 18.6.47.

Making Buttons, Button Blanks and Similar Articles from Plastic Materials. J. H. Goode.

B.P. 589,337. Application date: 6.9.43. Accepted: 18.6.47.

Improved Polymerization Process. J. J. P. Staudinger and M. D. Cooke. To: The Distillers Co., Ltd.

Polymerization of vinyl chloride and/or vinylidene chloride or mixtures thereof with other polymerizable compounds under the influence of a peroxidic catalyst in the presence of an acidic diluent (acetic acid).

B.P. 589,353. Application date: 17.11.44. Accepted: 18.6.47.

Process for the Production of Rubber-like Polymers. Communication from Standard Oil Development Co.

Low-temperature polymerization of iso-mono-olefins and diolefins by treatment with Friedel-Crafts catalysts. Refers specifically to isobutylene and isoprene.

B.P. 589,360. Application date: 21.8.44. Convention date (U.S.A.): 20.8.43. Accepted: 23.6.47.

Production of Improved Halogen-containing Polymers and Inter Polymers of substituted monoethylenic Compounds. E. I. du Pont de Nemours and Co.

B.P. 589,393. Application date: 14.11.44. Accepted: 19.6.47.

Improved Process for the Low Temperature Polymerization of Olefinic Materials. Communication from the Standard Oil Development Co.

B.P. 589,434. Application date: 10.6.43. Convention date (U.S.A.): 10.7.42. Accepted: 20.6.47.

An Improved Process for the Copolymerization of Styrene and/or Homologues thereof. Standard Oil Development Co.

Low-temperature polymerization of styrene and its homologues in the presence of a Friedel-Crafts catalyst.

B.P. 589,489. Application date: 4.5.44. Convention date (U.S.A.): 13.12.43. Accepted: 23.6.47.

Improvements in coated Rubber Hydrochloride Films. To: Wingfoot Corporation.

Composite film of rubber hydrochloride coated with a benzene soluble vinyl chloride/vinylidene chloride copolymer suitable for heat sealing.

B.P. 589,492. Application date: 9.6.44. Accepted: 23.6.47.

Improvements in Thermoplastic Synthetic Resin Articles. M. Simpson. To: Plast-Applied Products, Ltd.

Furniture from laminated thermoplastic resin material incorporating one or more layers of fabrics of an ornamental character.

B.P. 589,499. Application date: 24.1.45. Convention date (U.S.A.): 24.1.44. Accepted: 23.6.47.

Rubber-like Products. To: E. I. du Pont de Nemours and Co.

Rubber-like products manufactured by heat curing at 100 degrees C. or higher an intimate mixture of an ethylene/vinyl acetate interpolymer and sulphur (or a material capable of liberating sulphur), an accelerator for vulcanization and a Group II metal oxide.

B.P. 589,546. Application date: 25.3.43. Convention date (U.S.A.): 2.4.42. Accepted: 24.6.47.

Improved Process for the Dehydrogenation of Hydrocarbons. To: Standard Oil Development Co.

Catalytic dehydrogenation of butylene to butadiene.

B.P. 589,568. Application date: 24.1.45. Convention date (U.S.A.): 28.1.44. Accepted: 24.6.47.

Process for the Treatment of N-Alkoxymethyl Polamides. To: E. I. du Pont de Nemours and Co.

Treatment of N-alkoxymethyl polyamides to increase their melting point, to reduce their solubility and to improve their mechanical strength with regard to boiling water.

B.P. 589,577. Application date: 28.2.45. Convention date (U.S.A.): 28.2.44. Accepted: 24.6.47.

Manufacture of Interpolymere of Vinylidene Fluoride. To: E. I. du Pont de Nemours and Co.

B.P. 589,635. Application date: 14.3.45. Accepted: 25.6.47.

Improvements in or relating to Floor Covering and the like Material. L. V. Hughes and A. Porter.

B.P. 589,645. Application date: 11.4.44. Accepted: 26.6.47.

Improved Method of Applying Surfaces or Coatings by Spraying. C. L. Lumb.

Flame spraying of metals on to a metallic surface which has previously been coated with a synthetic resin cement.

B.P. 589,654. Application date: 19.9.44. Accepted: 26.6.47.

Synthetic Resin Coating Composition. G. W. Stockton. To: J. Sankey and Sons, Ltd.

Non-hygroscopic, rust-preventing coating for steel laminations for electrical appliances. A resinous-base material is prepared from an aryl or alkyl substituted phenol by reaction with formaldehyde; the fusible intermediate is mixed with a fatty oil and then heated with cobalt and/or lead acetate. The liquid mixture is subsequently cooled, emulsified with ammonia and is then ready for application to steel sheets, which are afterwards stoved.

B.P. 589,695. Application date: 18.5.43. Convention date (U.S.A.): 23.5.42. Accepted: 27.6.47.

Improvements in and relating to Synthetic Resinous Condensation Products. To: The British Thomson-Houston Co., Ltd.

Synthetic resin produced by heating an aldehyde together with diamino-s-triazinyl chloro (or bromo) carbomethyoxyethyl-sulphide and a partially cured phenol formaldehyde resin.

B.P. 589,714. Application date: 28.3.45 Convention date (U.S.A.): 29.3.44. Accepted: 27.6.47.

Fabrication of Articles consisting essentially of a Polymer of Tetrafluoroethylene. To: Imperial Chemical Industries, Ltd.

Production of articles by pressing shaped bodies from Polytetrafluoroethylene powders, sintering the bodies so obtained at temperatures exceeding 327 degrees C. and slowly cooling afterwards.

B.P. 589,715. Application date: 28.3.45. Accepted: 27.6.47.

Improved Polyvinyl chloride Composition. L. B. Morgan, P. Russell, A. A. Gibson, R. A. Kinnear and R. G. Heyes. To: Imperial Chemical Industries, Ltd.

Preparation of polyvinyl chloride dispersions having a long storage life.

B.P. 589,717. Application date: 28.3.45. Accepted: 27.6.47.

Improvements in or relating to Synthetic Resins. G. E. Little. To: The Chemical Research Laboratory, Teddington.

Production of a resin suitable for a cold-setting neutral gap filling glue for wood, by condensation of resorcinol and formaldehyde in two stages. The first stage leads to a stable syrup which is subsequently hardened by addition of more formaldehyde or polymer.

B.P. 589,759. Application date: 31.3.45. Accepted: 30.6.47.

Improvements in or relating to Plastic Material in Form suitable for Use for Packing or Sealing Purposes or Methods of Making same. T. Stuart. To: B.B. Chemical Co., Ltd.

B.P. 589,861. Application date: 5.2.44. Accepted: 2.7.47.

An Improved Process for the Polymerization of Olefins. To: Communication from

the Standard Oil Development Co. Catalytic process for polymerizing olefins with a catalyst comprising a fully arylsubstituted alkyl free radical (tripara tolylmethyl). Refers to the polymerization of isobutylene, styrene, butadiene, isoprene and pentadiene.

B.P. 589,984. Application date: 6.4.45. Convention date (U.S.A.): 12.4.44. Accepted: 4.7.47.

Improvements in the Stabilization of Cellulose Ethers. To: British Celanese, Ltd.

Heat stabilization of cellulose ethers (ethylcellulose) by dissolving the C. ether in a solvent consisting of or comprising a polar solvent (ethylalcohol or pyridine) agitating the solution for at least three hours and subsequent precipitation of the ether by means of a liquid which is a non-solvent for the liquid used to dissolve the ether: e.g., water in the case of pyridine.

B.P. 589,985. Application date: 6.4.45. Convention date (U.S.A.): 11.4.44. Accepted: 4.7.47.

Improvements in or relating to the Cutting of Thermoplastic Webs. To British Celanese, Ltd.

B.P. 589,906. Application date: 29.2.44. Accepted: 3.7.47.

Improvement in Thermo-Setting Resins. R. L. J. Farina. To: Jicwood, Ltd.

Process of effecting final polymerization of a permanently fusible condensation product of resorcinol and formaldehyde by adding to the condensation product such an amount of 10 N. Sodium hydroxide as to make up with the formaldehyde solution (37 per cent.) to 84-100 parts of solution by each 100 parts of resorcinol.

B.P. 590,000. Application date: 9.4.45. Accepted: 4.7.47.

Improvements in or relating to Resinous Condensation Products. H. S. Lilley. To: Imperial Chemical Industries, Ltd.

Process for the preparation of oil soluble resinous products from vinyl aromatic hydrocarbons (styrene) by adding thereto a methylene quinone compound (O-methylene quinone) and heating the mixture in the presence of a catalyst for the vinyl compound (borofluoro-acetic acid or stannic chloride).

B.P. 590,001. Application date: 9.4.45. Accepted: 4.7.47.

Improvements in or relating to the Manufacture of Organic Solvent Soluble Cellulose Ethers. F. G. Larmont. To: Imperial Chemical Industries, Ltd.

B.P. 590,002. Application date: 9.4.45. Accepted: 4.7.47.

Improvements in the Production of Viscous Aqueous Alkaline Solutions of Vegetable Globulins suitable for Conversion into Artificial Filaments. W. Sever. To: Imperial Chemical Industries, Ltd.

B.P. 590,015. Application date: 9.4.45. Accepted: 7.7.47.

Production of Unsaturated Carboxylic Acids and Esters containing Fluorine and Polymers thereof. L. McGinty. To: Imperial Chemical Industries, Ltd.

Refers to the production of monomeric and polymeric fluoroacrylates.

B.P. 590,042. Application date: 10.4.45. Convention date (U.S.A.): 13.4.44. Accepted: 7.7.47.

Improvements in or relating to a Process for the Working of Polyethylene Compositions. To: Bakelite, Ltd.

Process of working polyethylene compositions in contact with hot surfaces by incorporating a proportion of a polyhydric alcohol ester or a metal salt of a monocarboxylic fatty acid which has from 12-24 carbon atoms in the molecule. Examples quoted: Oleic or ricinoleic acid and their lead, copper, cadmium, aluminium or zinc salts in particular; esters of a glycol, glycerol, sorbitol.

B.P. 590,049. Application date: 14.4.45. Convention date (France): 31.5.44. Accepted: 7.7.47.

Improvements in or relating to Joining and Registering Devices for Moulding Boxes. B. Faure.

B.P. 590,052. Application date: 11.4.45. Accepted: 7.7.47.

Improved Hot-Melt Compositions. W. E. F. Gates. To: Imperial Chemical Industries, Ltd.

Sealing or coating composition comprising polythene (Alkathene grade 200) and chlorinated naphthalene. Such coatings may be applied to steel and other metallic articles for rust prevention and may be stripped off before use; they are also useful for sealing stoppers and as sealing compounds for dry batteries.

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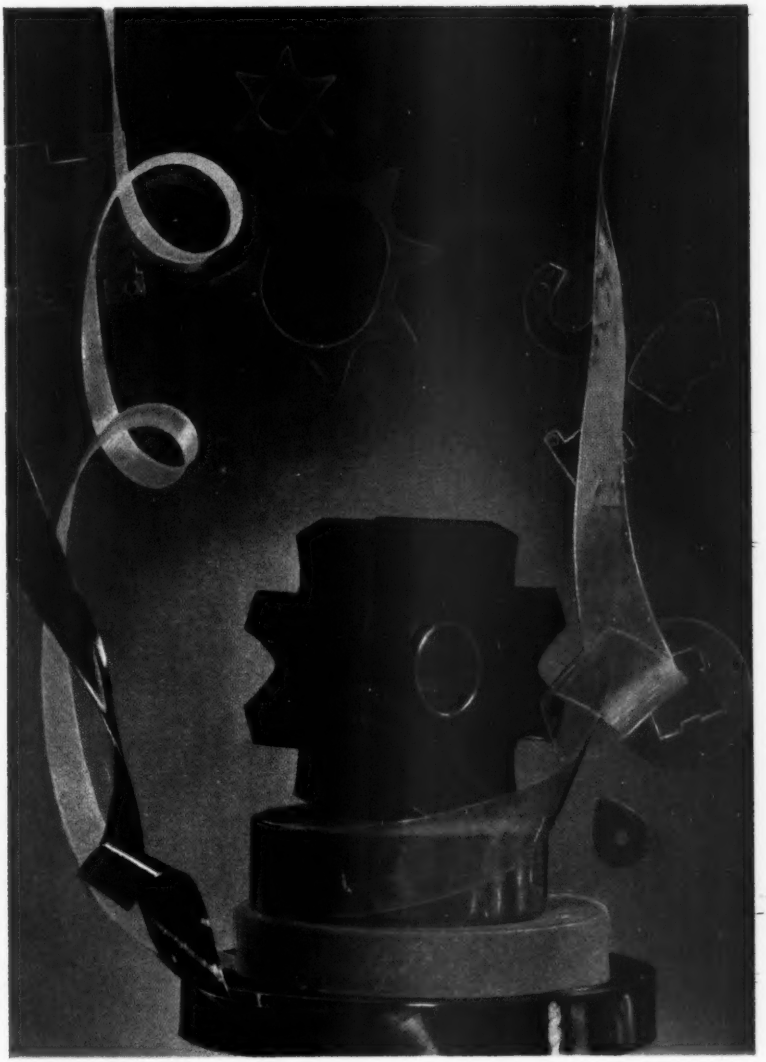

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The Microscopic Examination of Plastic Materials

VI.—Mouldings (Fillers)—(f) Fibrous Materials (Contd.)

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

HAVING examined the possibilities offered by esparto-grass as a filler, it is now proposed to turn to another monocot fibre—that produced from the African fan palm, which yields crin vegetal. Whereas there exists a great morphological difference between these two plants, there are, nevertheless, certain characteristics on which crin vegetal fibre is similar to esparto.

The crin vegetal fibre elements have a similar morphology and exhibit felting properties in very much the same manner as the esparto fibre element. Fig. 219 shows some of the fibre elements at a magnification of 40 diameters; here it will be noticed that they are generally similar to the esparto fibre in size and shape, inasmuch as they have the same evenly tapered pointed ends. In some cases these elements are seen to have been subjected to growth modification, as far as shape is concerned, such as the element marked A and the pair marked B, which will be seen to be bent at a point somewhere along the body of the fibre, but in general the ends of these elements show a remarkable uniformity of size as indicated by the group of fibre ends shown at D. The structure shown at C is not the end of a fibre, but the point at which an element has been cut during the preparation of the specimen for microscopical examination.

As the crin vegetal is mainly a leaf fibre, it will be appreciated that the commercial product may be expected to contain a proportion of extraneous matter adherent to the fibre proper. In practice, we find the fibre to be somewhat coarse and accompanied by a fairly considerable proportion of extraneous matter. A portion of a whole fibre, as obtained commercially, is shown in Fig. 220, magnification 100 diameters, from which it can be seen that the actual fibre indicated to be occupying the dimension A is a clean, compact structure, but that it is covered on one side by a layer of extraneous tissue, shown to extend to a thickness B.

This tissue consists of masses of thin-walled, soft, parenchymatous cells, which go to make up the live tissue and pith in the living plant and as such there must, of necessity, be present much protein matter and starch, sugar, etc. In the specimen illustrated, the extraneous matter is to be seen investing only a portion of the outer surface of the fibre

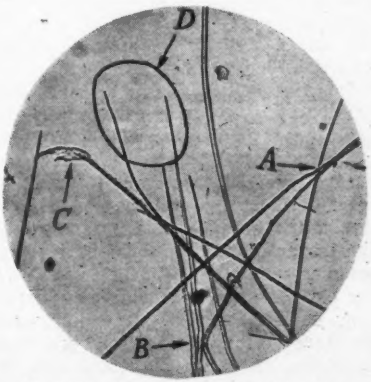


Fig. 219.—Crin vegetal fibre elements. Mag. 40 diameters.

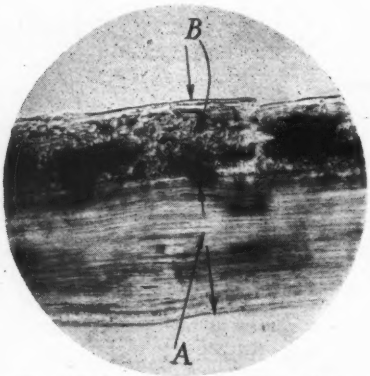


Fig. 220.—Crin vegetal, whole fibre. Mag. 100 diameters.

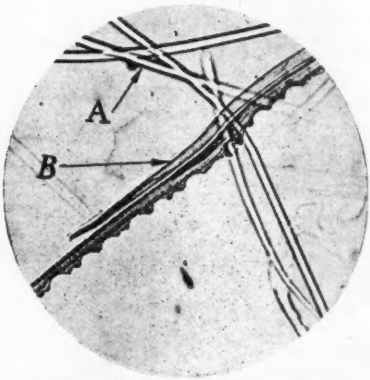


Fig. 221.—Crin vegetal fibre elements. Mag. 100 diameters.

(which, it must be remembered, consists of an entire vascular bundle); this is because parts of the sheath of soft tissue have been removed either in the stripping of the fibre—although it would be far better if matters could be so arranged that this unwanted portion was entirely removed—or in the processing of the sample. In any event, it serves a useful purpose, in so far as it illustrates the thickness of the sheath, on the one hand, and clean outline of the fibre on the other.

From the foregoing it will be apparent that this fibre leaves much to be desired from the point of view of its being of use as a potential source of filling material, because the presence of the extraneous matter constitutes a serious drawback, by virtue of the necessity for removing it before entertaining any idea of reducing the fibre to the required form. Nevertheless, the material is worthy of closer examination, as, no doubt, the question of the removal of the unwanted portion could be brought to an economical basis if the demand for the cleaned fibre were sufficiently great.

A consideration of the microscopic structure of the crin vegetal fibre must inevitably lead to certain conclusions, the chief of which is that due to the fact that the plant is a monocotyledenous variety, the fibre when extracted consists of the greater portion of the vascular bundles; indeed, as there is so much soft tissue present, it is more probable that in the majority of cases the fibres are entire vascular bundles. This assumption clearly indicates the probability of the existence of xylem tissue elements in the fibre, which should be capable of demonstration when the fibre is reduced to its constituent elements.

In Fig 221, showing some of the fibre elements at 200 diameters, we see two distinct types of cell represented. The now familiar phloem tracheids are seen at A, while at B we see two typical xylem elements, one of which possesses a relatively smooth exterior surface, whilst the other is deeply serrated along one side, probably as a result of lying in juxtaposition to a heavily lignified spiral vessel, which would account for the moulding of this side. It will be noticed that the xylem elements as seen in Fig. 221 are appreciably darker in tone when compared to the ordinary phlœm tracheids at A. The reason for this lies in the use of safranine as a straining reagent, which is a powerful lignin stain; thus, it can be demonstrated that these xylem elements are more highly lignified, as may be expected, by virtue of their deeper staining. At the same

time, the phloem elements show no signs of taking up safranine, thus indicating the absence of lignin, although it must be remembered that the elements were obtained in this condition by alkaline treatment, which, although not entirely removing the lignin from the more highly lignified elements, will in all probability be responsible for the entire removal of this substance from the phloem elements, which are in this instance only very lightly lignified.

Apart from these xylem elements, the phloem tracheids are characteristically lacking in outstanding details of microscopic structure, which might be of assistance in identification; in fact, one might almost claim the structureless nature of the elements as their best guide to identification. In general, the fibre elements are possessed of unusually thick walls and a very narrow lumen, as seen in Fig. 222, which shows one of these elements at a magnification of 550 diameters under polarized light with the system crossed.

From this illustration the thick walls and very narrow lumen of the element are easily distinguishable. The effect of this will be to stiffen the element and keep the lumen open, so that complete impregnation of the unit should be relatively easy to accomplish provided that

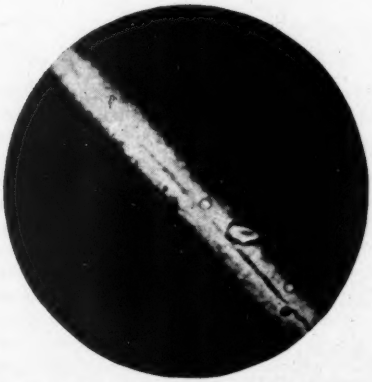


Fig. 222.—Crin vegetal fibre element showing narrow bore. Mag. 550 diameters.

Fig. 223.—Crin vegetal fibre element and pith cells. Mag. 100 diameters.

the ends of the bore are open so as to allow free access of the resin. The reason for this will be appreciated when it is realized that penetration through the walls cannot be relied upon in this case, as the micellar structure would appear to be very close indeed, as may be concluded from the fact that it was not possible to demonstrate the existence of any structure, spiral or otherwise, in this particular specimen. So that any assumption involving the possibility of impregnating the element through the walls should be ignored.

Thinking along these lines, then, it is clear that a filler consisting of entire elements of this nature would possess one inherent drawback, inasmuch as each element would contain a pocket of air in the form of its lumen. Although this may be regarded as being mitigated to some extent by the small proportions of the pockets, as the ideal concept visualizes perfect homogeneity with no air at all present, we must, of necessity, acknowledge the existence of this disadvantage, which may be offset to a not inconsiderable extent by using the material in the finely cut up form, as previously suggested, hereby insuring that the maximum number of elements have at least one end of the lumen open, so that the resin may fill it with the least difficulty.

The presence of the extraneous matter in this fibre will, of course, constitute a factor requiring serious consideration when evaluating this material, as the relatively high proportion of this type of tissue is a disadvantage which is not easily overcome. There are two distinct types of cell to be found in this soft tissue, consisting of thin-walled parenchyma, as shown in Fig. 223 at a magnification of 100 diameters and from which it can be seen that they are typical cells of their kind with very thin cellulosic walls.

These cells lie farthest away from the vascular bundles in the general structure of the leaf as they are the remnants of what is known as the pallisade tissue, this is that most important of structures which is responsible for the operation of photosynthesis in the plant. In life this tissue consists of a layer or layers of the elongated cells shown orientated on end (hence the name pallisade). The cells arranged in this manner form a layer immediately beneath the thin transparent cuticle of the upper surface of the leaf. They contain numerous chlorophylacious bodies known as chlorophasts, which are responsible for initiating the whole chain of reactions, ending in the production of starches and sugars. As the walls of these cells have to function as semi-permeable membranes, their extreme thinness will be appreciated.

In the condition in which these pallisade cells are found in the commercial fibre, they are a constituent of "dead" tissue and as such contain no protein or organic matter, which is clearly the case with the cells illustrated, hence they are merely minute bags of thin cellulose film and in regarding them as an impurity it is necessary to take into account the manner in which they function as such. Thus, so far as mechanical properties are concerned, they would be responsible for a considerable loss of strength, but they would not constitute such a serious menace if their presence were judged by their effects on the electrical properties of a moulding produced from powder containing this

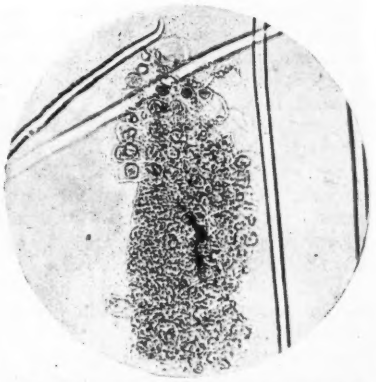
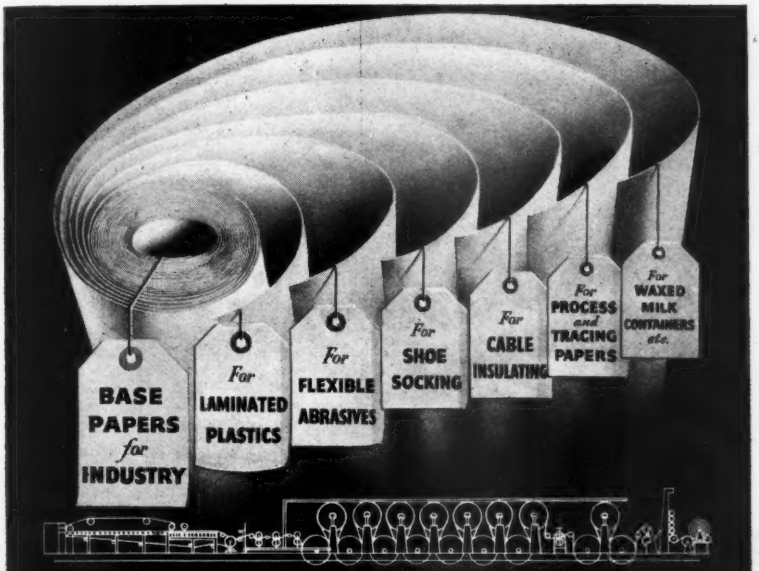


Fig. 224.—Crin vegetal fibre elements and extraneous soft tissue cells. Mag. 100 diameters.

material as a filler. However, as a material has to be evaluated on its total effect, as both mechanical and electrical strength are the characteristics required, we must classify this tissue as an impurity.

The pallisade tissue, however, constitutes only a small fraction of the total extraneous matter as it lies along only one side of the vascular bundle. The greater part of the bulk of this impurity is made up of the spongy tissue of the leaf, which consists of cells concerned with the other life processes of the plant. A group of these is illustrated in Fig. 224, magnification 100 diameters. It will be noticed from this photograph that these cells are much smaller than those found in the pallisade tissue, and, what is more important still, they distinctly show the presence of nuclei, which indicates in turn the presence of appreciable quantities of protein matter and, very likely, sugars and starches. The detrimental effects of these substances, when present in a filler, need no emphasis; sufficient to say that they are the least desirable of the substances to be found in this extraneous matter, and, unfortunately in this case, they are present in the greatest proportion.

In summing up the information obtained about this fibre, we may say that the fibre itself shows some not



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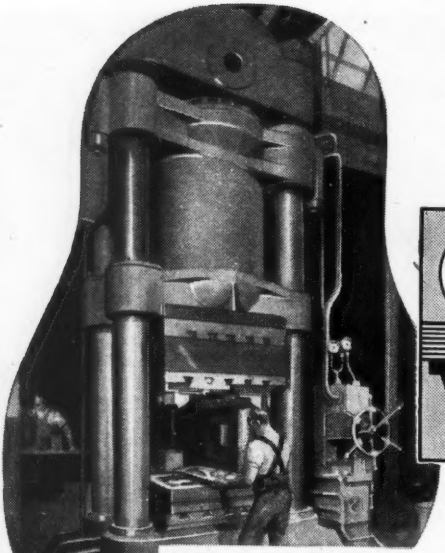

thoughts on presses

While it is neither necessary nor desirable to use a sledge hammer to crack a nut, it is a fact that in the plastics moulding trade large articles can only come from large presses. It is equally obvious that very large numbers of articles can only be produced in a short time from a very extensive plant.

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Fig. 225.—Phormium tenax, whole fibre, showing contamination. Mag. 100 diameters.

inconsiderable promise as a raw material for filler manufacture, but owing to the presence of appreciable quantities of undesirable matter, its utility is much decreased; indeed, one would be justified in saying that with this latter present, the fibre, as found commercially, is of very little use to the plastics industry, for the aforementioned purpose. On the other hand, if it is capable of being produced as a clean fibre, then its latent possibilities are much greater, provided always that the cost is low enough to warrant its use.

The fibre known as New Zealand flax is extracted from the leaves of the flax lily (Phormium tenax), native to New Zealand, where it is cultivated, although also grown in various parts of the world when climatic conditions allow. The leaves of this plant develop to a considerable length, often well over 5 ft.; this means that the fibres are long in proportion and they are extracted from the leaves by a preliminary scraping process followed by a combing out operation. Owing to the smaller proportion of other tissues in the leaves as compared to the stem, the difficulty of extracting the fibre is not so great and hence a retting process is unnecessary, as with the stem fibres, but as can be expected with mechanical extraction, the fibres are in the form of bundles of unequal size; they may, however be quite easily separated by mild friction. By these means it is possible to extract some 10 to 14 per cent. of fibre from the 20 per cent. contained in the leaves (on a weight basis) which would seem to suggest that the process of extraction might be improved somewhat so that the maximum amount of fibre might be extracted.

In general, the commercial New Zealand flax fibre is very white in colour and soft and flexible, possessing lustre to a high degree. These facts, when taken into consideration with the strength exhibited by this material, would appear to indicate possibilities for its use as a filler for light-coloured mouldings based on the clear resins. An indication of the tensile strength of this fibre is given by the following comparison of ordinary flax and hemp:—

Fibre	Tensile strength arbitrary
Phormium tenax	100
Flax	49.5
Hemp	70

It will be seen that common flax is only about half, and hemp about three-quarters the strength of Phormium tenax.

Being components from a monocot leaf, the fibres of Phormium tenax are similar in structure to those of crin vegetal, thus they are constituted in the main of fibro vascular bundles, which, in the living leaf, are distributed throughout the parenchymatous tissues. Although in the case of New Zealand flax the leaf is large and flat, and not rolled up as in the case of Esparto grass, from this observation it may be expected that in the extraction of the fibre a certain amount of extraneous soft-tissue substance will be taken out with it. Thus we find in practice that pieces of parenchyma, and even, in most cases, the epidermis, are adherent to the fibres as used for commercial purposes. The extent to which this may exist is well seen in Fig. 225, showing a piece of contaminated fibre at a magnification of 100 diameters, and

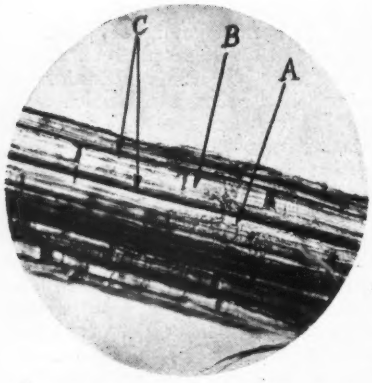


Fig. 226.—Phormium tenax, whole fibre, Mag. 100 diameters.

from which it will be noticed that the actual fibre occupies only a minor portion of the whole, as evidenced by the central black band dimensioned at A. On the upper side of this fibro-vascular bundle we see a layer of dense pallisade tissue B, and on the lower side a wide area of soft parenchymatous tissue C.

Although in this case there is a great deal of this extraneous tissue present, it should not be concluded from this that the commercial fibre in general is everywhere covered by it, for this is not the case; rather do these incrustations occur in isolated spots along the length of any given fibre, due to greater adherence of the soft tissues at these places, but whereas the percentage of extraneous matter is small, it is by no means insignificant when considering the New Zealand flax fibre, with regard to any possibilities it might have to offer as a filling material. It will thus be apparent that, once again, we have encountered a material suffering from the initial disadvantage of requiring pretreatment in order to remove unwanted substances before it can be used.

Having obtained some idea as to what to expect regarding the extraneous matter present, let us now examine the fibre in its cleaned condition. A portion of the clean Phormium tenax fibre is shown in Fig. 226, at a magnification of 100 diameters. No special efforts were made to clean this specimen; rather was it chosen as being a typical example of the commercial fibre when relatively free from extraneous matter. It will be seen from the photograph that there are still soft cells adhering to the outer surface of the fibre, such as those shown at A. It is the presence of similar elongated cells, of an epithelioid nature, which is responsible for what appears to be cross markings in this fibre, as shown at B, which are, in fact, the end walls of the cells just mentioned. However, the extraneous cells in this instance are insignificant in comparison to the fibre, which when compared to the previous example (Fig. 225) is seen to be very much cleaner in general.

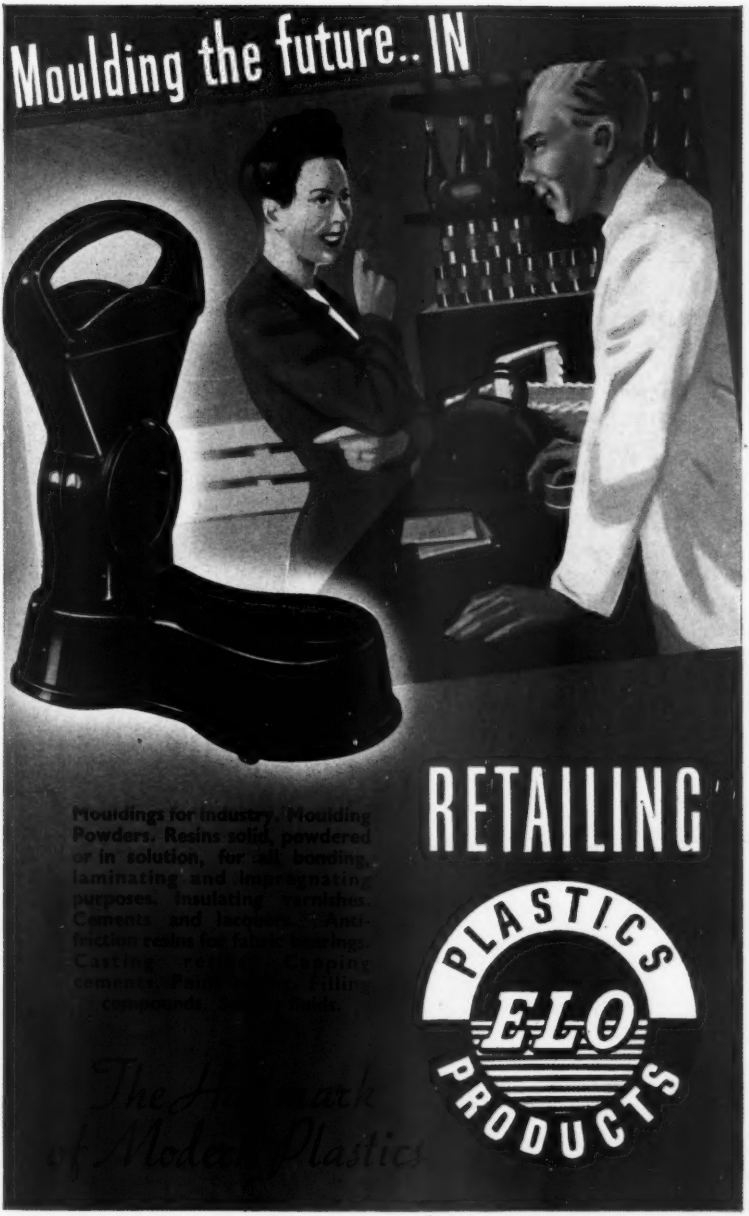
The fibre itself may be seen to be composed of densely compacted elements which are possessed of even bores. This is seen by reference to those marked C, which are visible by virtue of their being filled with air, which is left in situ with this end in view.

In so far as the microscopical structure of the Phormium tenax fibre is concerned, the elements exhibit the characteristic not commonly found in other fibres, of being easily separated from one another, in spite of the fact that they are lignified throughout the wall thickness of the cell, although it should be remarked that the total lignin content is small. Thus Matthews* quotes the following analysis of New Zealand hemp as being due to Church:—

Ash	0.63 per cent.
Water	11.61 per cent.
Gum (and other water solubles)	21.99 per cent.
Fat	1.78 per cent.
Pectin bodies (lignin, etc.)	1.69 per cent.
Cellulose	63.00 per cent.

Here it will be apparent that the lignin at most can only be in the proportion of 1.69 per cent. Apart from this, there does not appear to be any median layer present in the gross fibre, as found in other materials, which is in all probability the factor having the greatest influence on

* Matthews, "The Textile Fibres" (Wiley).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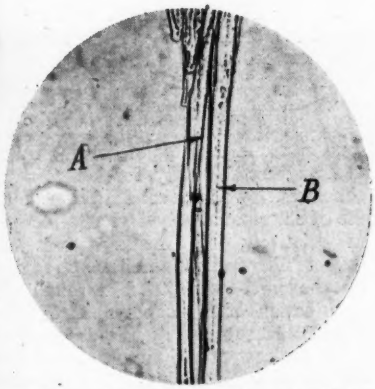

Fig. 227.—Phormium tenax, showing ends of fibres fitting together. Mag. 140 diameters.

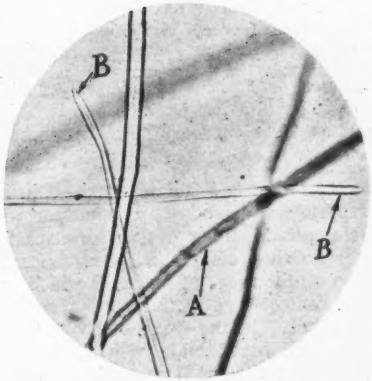

Fig. 228.—Phormium tenax fibre elements. Mag. 100 diameters.

this ease of separation. In spite of this, however, we have seen that this fibre is appreciably stronger than others of similar quality, such as hemp.

This strength is probably due to the close-packed nature of the structure. In Fig. 227 we see three fibre elements at a magnification of 140 diameters, from which it will be seen how closely the fibre elements are fitted together, the end of the element marked A tapering down to a fine point and fitting very closely between the other two elements shown. The dotted lines, such as those shown at B, are, in reality, air bubbles in the bores of the elements, which serve to show the narrow lumen so characteristic of this fibre.

The elements themselves are regular, and the thickening of the cell wall is also regular. As a general rule, the surface of the fibre element is smooth, although at times it is possible to detect an odd element here and there, which is wavy and irregular in outline. Such an element is seen at A (Fig. 228), at a magnification of 100 diameters; although this element is not exactly in the plane of focus, it is sufficiently sharp for the irregular outline to be distinguished. Two typical ends of elements are seen at B, from which a good impression of regularity of the ends may be obtained.

With regard to their physical dimensions, the fibre elements of Phormium tenax vary from 5 to 15 mm. in length and from 10 to 20 μ. in diameter, so that it will be seen that the average L.B. ratio is in the region of 550 to 1. This figure will, of course, be unsuitable in a filler, so that again we have a material which promises to be more efficient when used in the "chopped up" form rather than when it is reduced to its histological elements.

In transverse section these fibres are almost circular, with the diameter of the lumen generally somewhat less than the thickness of the wall. This indicates a fibre element possessing an open lumen, which, as we have seen, may be expected to facilitate the impregnation of the filler particle; but in evaluating this fibre for use as a starting material for fillers, the great disadvantage of the quantity of extraneous matter present should be taken into account. However, as has already been suggested, it is highly probable that in the event of the demand for a clean fibre of this sort being high enough, the question of producing a material of the desired quality would, no doubt, be thoroughly considered, and the economical production of a clean fibre developed.

(To be continued.)

PLASTICS IN GERMANY

(*continued from p. 552*)

was shut down for overhaul and was still active. The yields were 96-97 per cent., of which 2-3 per cent. was mechanical loss. The principal by-product is ethylidene dichloride.

F.I.A.T. Final Report 886.—Existing reports on melamine are not clear with reference to either process or capacity; nor do they contain adequate information on the usage of materials which permit estimates of manufacturing costs to be made. In the present report, which has been based on a visit to the I.G. Melamine plant at Fechenheim, there are operating instructions for the plant, and also considerable detail regarding cost of conversion.

F.I.A.T. Final Report 1071.—Two processes for chlorinated polyvinyl chloride are described in detail in this report; one deals with solvent, the other with suspension chlorination. The product with highest softening point was used mainly for fibres and textiles; the other product with highest solubility for lacquers and adhesives. Two inherent objections to the use of chlorinated polyvinyl chloride were its relatively low melting point and its instability in light and heat. A remedy to the first was tried through the chlorination of the copolymers of vinyl chloride, but this work was dropped because the cost of satisfactory copolymers was found to be too high. The objection of instability was partly overcome by the use of stabilizers, which included dioxydiethyl sulphide and thiodiglycol.

Index to Advertisers

	Page
Almex, Ltd.	xlvi
Bakelite, Ltd.	xxxii
Barclays Bank Ltd.	li
Barber & Duffy, Ltd.	lviii
Baynes, Charles, Ltd.	liv
Birkby's, Ltd.	xxxix
Blackfriars Engineering Co., Ltd.	xviii
Blayden, Victor, & Co., Ltd.	xxiv
British Gas Council	x
British Geon, Ltd.	xxix
British Industrial Plastics, Ltd.	xli
British Institute of Plastics Technology	l
British Moulded Plastics, Ltd.	xxxviii
British Mouldex Rubber Co., Ltd.	xvi
Butcher, Henry, & Co.	lii
BX Plastics, Ltd.	Inside Front Cover
Byson Appliance Co., Ltd.	liv
Catalin, Ltd.	Inside Back Cover
Chamberlain & Willows	liv
Cohen, George, Sons & Co., Ltd.	xi
Cole, E. K., Ltd.	xvii
Cole, R. H., & Co., Ltd.	xxii
Collis, J., & Sons, Ltd.	vi
Cornercroft (Plastics), Ltd.	xvi
Courtaulds, Ltd.	xliv
Crystalate, Ltd. (and Subsidiary Companies)	ii, iii, iv, & v
Dissoutter Bros., Ltd.	xix
Dohm, Ltd.	xx
Dominion Export Co., Ltd.	liv
Duraplex (Plastics), Ltd.	xviii
Duratube & Wire, Ltd.	xxvi
East Anglia Chemical Co., Ltd.	li
Erinoid, Ltd.	Back Cover
Ether, Ltd.	xlviii
Evans, Frederick W., Ltd.	lii
Ferguson, James, & Sons, Ltd.	xxxvi
Ferodo, Ltd.	viii
Firth-Vickers Stainless Steels, Ltd.	xxviii
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Fraser, Andrew, Ltd.	ix
Galea, Gilbert	xliv
Gardner, Wm., & Sons (Gloucester), Ltd.	xxxiv
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Gosheron, John, & Co., Ltd.	xlviii
Greenwich Leathercloth Co., Ltd., The	xl
G.R.L. Plastics, Ltd.	xlii
Haigh, John, & Co., Ltd.	l
Harris, Alfred, & Co., Ltd.	xliv
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Kent Mouldings	xx
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Micanite & Insulators Co., Ltd., The	xxxv
Ministry of Supply	xliii
Monsanto Chemicals, Ltd.	Front Cover
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Sellotape	xlv
Steele & Cowlishaw, Ltd.	l
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Synchronome Co., Ltd., The	xliv
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Leaves from a Moulder's Notebook

This is the eleventh in a series of notes by the B.I.P. Development Department on the problems of the moulder and designer. B.I.P. will send a copy of the previous notes on request and will welcome comments and enquiries.

moulded hinges

The production of slender moulded hinges in Beetle may turn out to be rather heavy in scrap with frequent replacement of coring pins if the proper technique is not used.

Research has been undertaken on this problem to prescribe the best methods of moulding a hinge as illustrated in Fig. 1.

Piano wire has been proved best for coring pins and it should be of a minimum diameter of 0.072 in. The knuckle diameter of the hinge should be not less than $\frac{5}{32}$ in. and, provided preheating (preferably H.F.) and pressure or flow control are used, trouble and scrap should be eliminated.

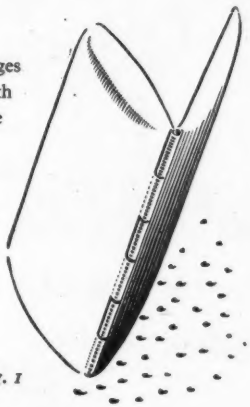

Fig. 1

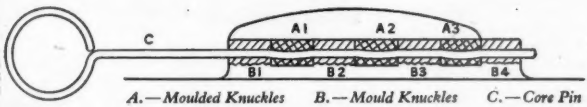

Fig. 2

A.—Moulded Knuckles B.—Mould Knuckles C.—Core Pin

SKETCH OF PIN IN CIGARETTE CASE MOULD

Fig. 2 shows what happens when normal moulding methods are used without preheating or flow control. The withdrawal of the coring pin, due to the straightening and flexing which it undergoes in being withdrawn, has been proved to require a pull of 50-60 lb., and in some cases as much as 80 lb. The coring pin becomes fatigued, heavy wear is caused to the coring pin hole in the mould, and tightness of fit of the hinge in the moulding results. With the correct method described above good mouldings with smooth and fast production will result, and the withdrawal of the coring pin will need a pull which never exceeds 40 lb. and is usually between 10 and 20 lb.

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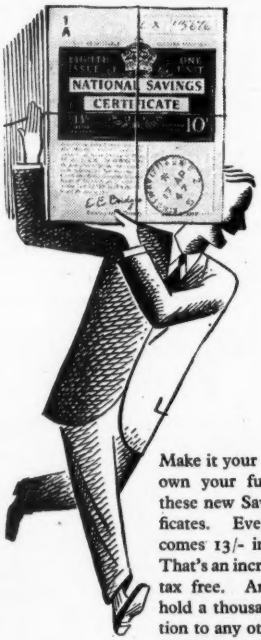

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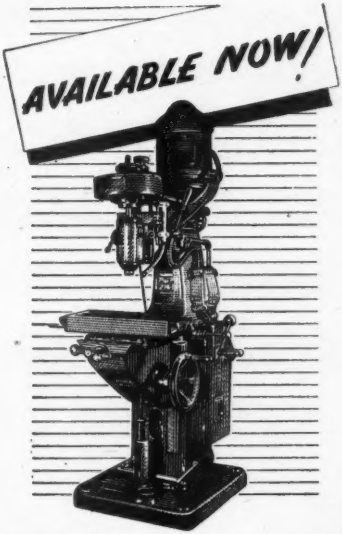

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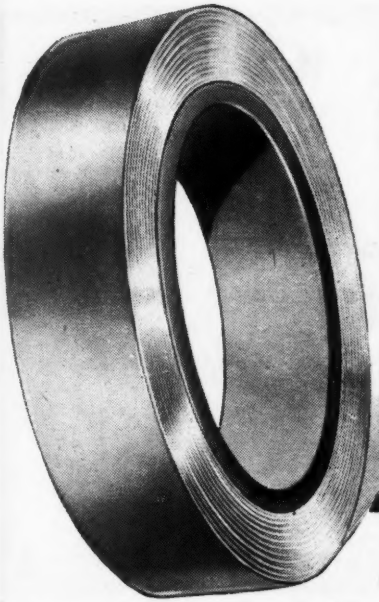

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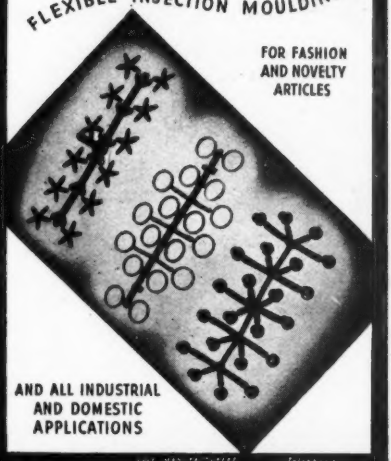

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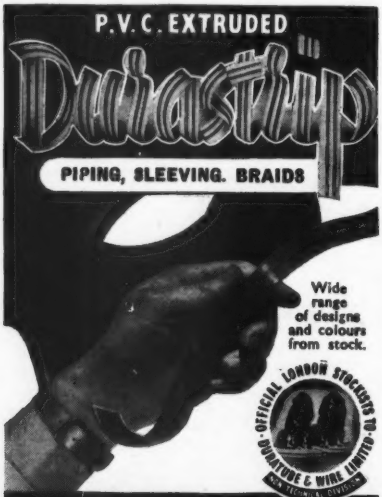

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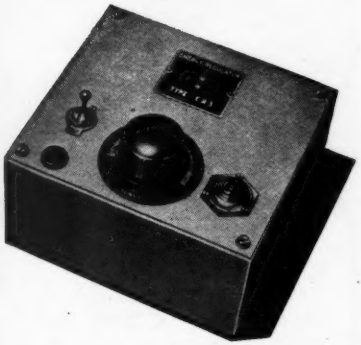

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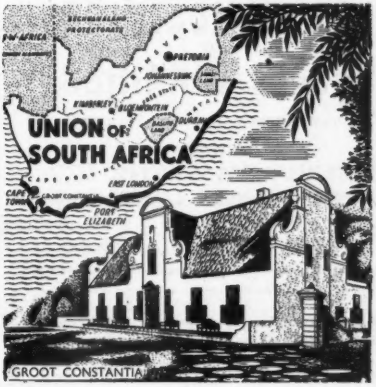

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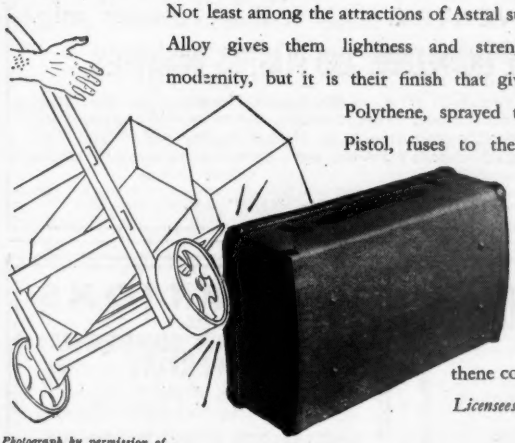

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Acetate and other Synthetic Mouldings. Modern Plant and Facilities

APPLIANCE Co LTD
WOOLFOLD, BURY, LANCS.
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BRITAIN'S LEADING HACK-SAW BLADE—

DING-DONG
PRACTICALLY UNBREAKABLE

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HIGH SPEED STEEL BLADES
Supplied by Tool Dealers, Engineers' Merchants, Mill Furnishers, etc.

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CLASSIFIED ADVERTISEMENTS

Rate 4d. per word, minimum 4/-
— Box Number Fee, 1/- —
Instructions should be addressed to "Plastics," Bowling Green Lane, London, E.C.1

AGENCIES

Established firm of wholesale distributors, excellent connection southern counties, modern warehouse, wish to contact manufacturers of all types of plastics, either as agents or cash buyers. D. H. Ridout and Son, Ltd., 12 Stedman Road, Southbourne, Bournemouth. zzz-409

Agencies Wanted

Agencies wanted for the sale of plastic and Perspex articles. Offices operating from all large cities. Send particulars for cash on delivery to N. Gerver, Plastic Sales Dept., 2-10 Marc Street, Hackney, London, E.8. Phone, Amherst 5805 (five lines). 130-25

AUCTIONEERS' ANNOUNCEMENTS

RICHARDS AND PARTNERS.
AUCTIONEERS, VALUERS AND SURVEYORS
of
INDUSTRIAL PROPERTY, PLANT AND MACHINERY.
GRANVILLE HOUSE, ARUNDEL STREET.
LONDON, W.C.2.
Phone, Temple Bar 7471 (four lines).
zzz-408

BUSINESSES, PREMISES, OFFICES, ETC.

Islington: 12-roomed house used for business. Small lift. Large yard with sheds. Two-floor workshop, about 1,000 sq. ft. With possession. Freehold for sale; moderate price. Apply to Chamberlain and Willows, 345 Goswell Road, E.C.1. Phone, Terminus 2241. 125-9

Injection moulding factory for sale. Modern machinery, spacious ground-floor premises, 21 years' lease. London suburb within easy reach of West End. Box 918, care of "Plastics." 125-19

DESIGN AND DRAWING

Plastics designers. Components, moulds, tools and plant planned, designed and detailed. Alex S. Godfrey, 64a Clapham High Street, London, S.W.4. 125-2216

Design and drawing capacity for plastics moulds (injection, compression, transfer) and component design development. Graystone Designs, 35 Winchester Road, Hampstead, N.W.3. Phone, Pri 7420. 125-25

MACHINERY, TOOLS AND PLANT

One Mitchell electrically heated drying cabinet, with indicating-type thermostat.
One 6 by 8 rotary cutter, with standard feed hopper and chute-type magnetic separator 18 ins. wide.
One electric pump, ½ h.p. 400/440v. Brook motor.
One polishing machine, with dust extractor, 1 h.p. 230v. Brook motor, automatic starter.
18 polishing machines, mounted, some automatic, and some self-starters.
Two unmounted polishing heads, 1 h.p. 230v. and 440v.
One S.H.3 injection-moulding machine, hydraulically operated, 10 h.p. motor drive. Box 9728, care of "Plastics." 125-2196

FOR SALE

Stainless Steel Enclosed VACUUM REACTION KETTLES or STILLS, approx. 1 ft. 10 ins. by 2 ft. 4 ins. deep, bolted top cover with manhole and glanded agitator entry, stainless steel agitator; mild steel outer jacket 50 lb. per square inch steam pressure, crown wheel and pinion fitted to agitator shaft; drive from fast and loose pulleys, bottom outlet, suitable for small-scale synthetic resin manufacture.

REED BROTHERS (ENGINEERING), LTD.,
BEVIS MARK HOUSE,
LONDON, E.C.3.
Phone, Avenue 1677-8. Grams, Replant Ald London. 126-3004

Two sets hydraulic pumps, by Fielding and Platt, nearly new, horizontal, approximately 200 gallons per minute at 1,750 lb. per sq. in., reduction gear 730 to 120, motor 290 h.p., 400/3/50. Thompson and Son (Millwall), Ltd., Cuba Street, London, E.14. zzz-448

Machinery, Tools and Plant (contd.)

FOR SALE.
MODERN DESIGN HORIZONTAL HYDRAULIC PUMPS.
Details as follows:

Two modern design Unused Horizontal Three-throw Enclosed-type Hydraulic Pumps, model 38/173, by Davy and United Engineering Co., Sheffield, each having rams 3¼ ins. diameter by 12 ins. stroke, approximate capacity each 160 gallons per minute; crankshaft speed 150 r.p.m., pressure 2,240 lb. per sq. in., forced-feed lubrication, four-bearing-type crankshaft, arranged for motor drive through totally enclosed gearbox with double-helical teeth, ratio 740/150 r.p.m. by Turbine Gears, Ltd.; also Wellman Bibby couplings (no motor included). H.P. to drive, 275; 740 r.p.m.

The pumps are suitable for pressures up to 3,000 lb. per sq. in.

Two practically new modern design Horizontal Three-throw Enclosed-type Hydraulic Pumps, model L.10/U.31, by Fielding and Platt, Ltd., each having rams 4¼ ins. diameter by 10 ins. stroke, approximate capacity each 180 gallons per minute; crankshaft speed 120 r.p.m., pressure 1,750 lb. per sq. in., forced-feed lubrication, four-bearing-type crankshaft; each driven through totally enclosed gearbox with double-helical teeth, ratio 730/120, by Urquhart Lindsay and Robertson, by 290 h.p. slip-ring motor by Mather and Platt, Ltd., 400 volts, three-phase, 50 cycles, 730 r.p.m., with hand-operated starter.

The pumps are suitable for pressures up to 2,240 lb. per sq. in.

JOHN CASHMORE, LTD.,
GREAT BRIDGE, STAFFS.
Phone, Tipton 1101-3.
SOUTH WALES WORKS: NEWPORT, MON.
Phone, Newport (Mon) 3944-6. 126-39

12-in. motorized band sawing machine, convertible to cut steel or timber, £54 0s. 4d.; 6-in. bench-type motorized sanding machine, £64. Apply, McIntyre and Eastwood, Carr Road, Town Gate, Wyke, Bradford. 125-8

For disposal: Four modern self-contained motorized pump units for hydraulic moulding presses, all recently purchased new. Box 898, care of "Plastics." 125-17

Complete extrusion unit for sale, comprising Shaw P2 extruder, haul-off gear; cooling system. Dies for wire covering, tubing and shapes and three tons raw material. Ready for immediate operation. Box 805, care of "Plastics." 125-1

Machinery, Tools and Plant, Wanted

100-ton hydraulic down-stroke plastic presses (self-contained) required, complete with electrically heated platens. Blackfriars Precision, Ltd., 154-6 Blackfriars Road, London, S.E.1. Phone, Waterloo 4369, 6454. 125-x8988

Wanted: 150/250-tons upstroke press, with push backs. Box 703, care of "Plastics." 125-7

Francis Shaw ¾-oz. hand-operated injection moulding machine required. Please give full details. Box 846, care of "Plastics." 125-x773

PRODUCTION CAPACITY AVAILABLE AND WANTED

Pulverizing and grading of raw materials, Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-369

Repetition in Ebonite, Erinoid, etc. Capstan lathe work Mansell, Temple Street, Rugby 125-8451

Wanted, plastic articles of every description for export and British Isles. Representatives active in all parts. Can place large orders for export. Write N. Gerver, Plastic Dept., 2-10 Mare Street, Hackney, London, E.8. 131-394

Work wanted, tool room available for all sorts of press tools. Press work, assembling, spraying and all sorts of engineering to your design. Universal Components, Ltd., 19 Sunderland Terrace, W.2. Bay 6776. 131-392

We are able to undertake certain short or long runs of highly specialized medical and technical plastic moulded products. Injection, compression or sheet fabrication. Use our services for the preparation of prototypes. All inquiries strictly confidential. Box 7678, care of "Plastics." zzz-422

Production Capacity Available and Wanted (contd.)

Injection moulding capacity available on 3-oz. injection moulding machine for short and long runs. Box 9035, care of " Plastics." zzz-438

Capacity for design-manufacture of press tools, moulds, jigs, fixtures, repetition turning, springs and presswork. The Super Ease Tool Co., Highfield Works, Oakley Road, Redditch. 125-28

Injection moulding specialists have moulding capacity up to 4 oz. Consultants on all injection moulding problems. Please send inquiries to Box 9761, care of " Plastics." 125-29

Plastic manufacturer wanted for large number of very small articles. Protected design. Repetition work. Box REG, Mayfair Advertising, Ltd., 18 Thurloe Place, London, S.W.7. 125-38

Injection capacity available: up to 8 oz. Plastiers, Ltd., Reliance Works, 305-315 Hither Green Lane, Lewisham, London, S.E. Phone, Elt 1873. 125-3

Chromium plating. Capacity now available for polishing and plating. Good delivery and competitive prices. Consult us on all your plating troubles. W. and D. Electrical Co., 95 Park Road North, W.3. Phone, Aco 5930. 125-4

Raincoat welding capacity shortly available for large quantities. Box 705, care of " Plastics." 125-5

Embossing and reproducing of wording, designs and all matter carried out on plastics, leathers, showcards and all materials. L.I.S.T., Ltd., Fernhead Works, Fernhead Road, W.9. 126-3006

Well-established reputable custom moulder has capacity and material for home or export available for mouldings, both compression and injection and including E.M.B. 4-oz. machines. Immediate delivery from customers' own moulds. Box 807, care of " Plastics." 125-11

Aluminium spot-welding capacity available. Limit twice 16 S.W.G. Savage and Parsons, Ltd., Watford. Watford 6071. 125-15

Injection moulding capacity available with manufacturers specializing Polythene products. Assistance offered with tool design and manufacture in own tool room. Box AC22942, Samson Clarks, 57-61 Mortimer Street, W.1. 126-3245

Specialists in Polythene mouldings have capacity up to 8 oz. Tools designed and manufactured if required. Inquiries welcomed. Box 869, care of " Plastics." 125-x173

Though quite a small concern, our geographical position, coupled with really efficient production methods, allows us to execute large or small orders satisfactorily at pleasantly low prices. We have at the moment a limited capacity to offer for turning, finishing, polishing or assembling (drilling, etc.) plastic or metal articles. Edgar T. James, High Littleton, Somerset. 125-x842

Plastic products trade-marked, branded, ornamented, etc., by stamping in gold, silver, pigments; clocks, instruments, Perspex display units. The Superb Stamping Co., 84 Highbury Park, London, N.4. Can 1915. 127-x137

Repetition in ebonite, casein and all plastics, etc. Also brass and Dural. Export work preferred. Starr, 110 Mile End Road, E.1. 127-x1076

Inquiries invited for design and development work on plastics, also facilities available for toolmaking and mouldings. All inquiries treated in strict confidence. Box 774, care of " Plastics." 125-x597

RAW MATERIAL AVAILABLE AND WANTED

Wanted, plastic sheeting in all thicknesses from 1-16-in. to 1-in. Can place large orders for home and export markets. Please submit samples and prices to N. Gerver, 2-10 Mare Street, Hackney, London, E.8. 125-393

CUPREX, LTD.,
Stockists of I.C.I. Perspex,
Offer specially:
1/16-in., ⅛-in. and ¼-in. coloured.
Write for stock list and particulars to:—
FINSBURY PAVEMENT HOUSE,
120 MOORGATE,
LONDON, E.C.2. zzz-446

Ebonite and bakelite always in stock. Phone, Archway 3654. A. E. Goodeve, Ltd., 188a Seven Sisters Road, London, N.7. zzz-445

Regular supplies of imported plastics available. Urea, polystyrene, cellulose acetate, luminiscent cellulose acetate, ethyl cellulose, phenolic, moulding compounds, phenolic resins and adhesives, extruded polystyrene rods, celluloid in sheets, rods and tubes, cellulose acetate in sheets, casein sheets and rods, P.V.C. extrusion compound. Please send inquiries to Box 9205, care of " Plastics." zzz-442

Raw Material Available and Wanted (contd.)

P.V.C. clean strippings from cables, etc., blue, brown, red, yellow and black, first-class material, large quantities available, 1s. 6d. lb. Box 9744, care of " Plastics." zzz-443

For sale, P.V.C. scrap. Offers invited. Box 8494, care of " Plastics." zzz-426

Cellulose acetate scrap urgently required; best prices paid. Write Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. Phone, Metro. 9641-5. zzz-424

Perspex cut to requirements. Denny, 271 High Street, Acton, W.3. Acorn 5777. 125-2193

PERSPEX.
Official Stockists,
OFFER CLEAR AND PASTEL SHADES IN STANDARD SHEETS OR CUT TO SPECIFIC REQUIREMENTS;
Also
MOULDINGS OF ALL TYPES IN PERSPEX.
SYNTHENA, LTD.,
AKED STREET, VICAR LANE, BRADFORD.
125-2191

" Perspex " brand Acrylic sheet, new paper covered, clear and coloured, 1/16-in. to ½-in. thickness, in standard sizes. Box 9931, care of " Plastics." 125-x8651

Wanted, " Perspex " sheeting, all thickness, coloured and clear, in any sizes, multiple of six over 12 by 12; coloured and clear " Perspex " off-cuts; coloured 10-thou. cellulose acetate, suitable for lamp-shade making; large or small quantities purchased. Box 580, care of " Plastics." 126-3040

Large quantities of clean polythene, white, black and other colours, segregated. Box 9865, care of " Plastics." zzz-449

JOHN F. MANN, LTD.,
DIRECT IMPORTERS OF MOULDING POWDERS,
Offer
UREA FORMALDEHYDE,
PHENOL FORMALDEHYDE,
POLYSTYRENE, etc., etc.
Prompt and forward delivery.
143 CANNON STREET, LONDON, E.C.4.
Phone, Mansion House 1270.
125-2998

Urea formaldehyde moulding powder for sale, 15 tons immediate delivery, at 2s. 11d. per lb., carriage paid. Sample of powder on application; also large quantities of phenol formaldehyde at 2s. 6d. per lb., in black, walnut, red and green. Box 513, care of " Plastics." 127-3000

Urea formaldehyde moulding powder, ivory, offered ex-stock. Box 512, care of " Plastics." 125-2999

Plasticized P.V.C. compounds for extrusion, sheeting, moulding, etc., virgin grade, available for immediate delivery in wide range of opaque and translucent shades. Inquiries invited for plastic compounds for all purposes. East Anglia Chemical Co., Ltd., Street One, Aycliffe Trading Estate, near Darlington. 125-3005

Perspex and Crinothene, official I.C.I. stockists for North-West area, invite inquiries for flat sheet Perspex, clear and coloured, from 1/16-in. to ½-in. thickness; also official I.C.I. stockists of Crinothene. Plastics (Manchester), Ltd., 11 Whitworth Street, Manchester, 1. Phones, Central 0272 and 1725. zzz-447

Black Cellulose Acetate 52-in. by 24-in. by .06-in. thick, 2,000 sheets available semi-polished, first-class condition. Specification DTD.315. Immediate delivery. Box PP12356, Samson Clarks, 57-61 Mortimer Street, W.1. 126-3247

500 Sheets Cellulose Acetate, .080 thick, 54 by 27, matt finish. Offers wanted for the whole or part Box 809, care of " Plastics." 125-13

Liquidation Stock—perspex offcuts various shades, sizes, for immediate sale, highest offer. Box 808, care of " Plastics." 125-12

Bakelite sheets, perfect, new black, 1/16-in. thick, to clear stocks at 2s. 10d. per lb. Box 806, care of " Plastics." 125-10

2,417 lbs. new cellulose acetate moulding powder (seven colours), at 3s. 9d. per lb.; 197 lbs. C.A. scrap (first injection), colours, at 1s. per lb. To be sold as one lot. North Midland Plastic Products, 148 Siddals Road, Derby. Phone 45502. 125-38

Raw Material Available and Wanted (contd.)

S. R. F. FREED, LTD.,
THE STOCKISTS OF SHEETS, RODS, TUBES, OFF-CUTS AND SCRAP.
OFFER OTHER LINES WHICH CAN BE USED IN COMBINATION WITH PLASTICS, UTILIZING ANIMAL AND VEGETABLE PRODUCTS.

Such as tortoiseshell, horn, cleaned and prepared cattle bones for industrial purposes, vegetable ivory nuts, porcupine quills, goose and duck feathers, and barrels, etc.

S. R. F. FREED, LTD.,
27b HIGH STREET, SOUTH NORWOOD, S.E.25.
Phones, Livingstone 4042; Sanderstead 2056.
125-402

Highest prices paid for P.V.C. sheeting. Samples to Dept. A.S.T., Newton Home Products Co., Ltd., 93 Goldsmith Street, Nottingham. 127-x172

D. H. Ridout and Son, Ltd., Reg. Office 12 Stedman Road, Southbourne, Bournemouth. Phone, S'bourne 505 offer for immediate delivery.
10,000 ft. 1¼-in. plastic belting. First-class material, ribbed both sides, 3d. ft.
Two tons Perspex scrap, 1-16 in. to ¼ in. thick. Good sized pieces, from 1s 6d. lb., according to quantities and sizes required. Minimum 14 lb.
5 cwt. Paxilene sheets, 36 ins. by 36 ins., ⅛ in., ¼ in. and ⅜ in. thick, 1s. 6d. lb.
7 cwt. laminated sheets, 36 ins. by 36 ins., 48 ins. by 48 ins., 36 ins. by 72 ins., ¼ in. to ¾ in. thick, 1s. 6d. lb.
Brown plastic sheets, 8 ft. by 4 ft., from 1s. 4½d. sq. ft.
5 cwt. transparent acetate sheeting, .007 in. thick, 3s. 6d. lb.
50 tons coir fibre mattress stuffing, from 4d. lb., according to quantity required.
20 new opaque sheets orange acetate, 48 ins. by 21 ins. by 1-16 in., 6s. lb.
5,000 sq. yds. rubber flooring tiles, 12 ins. by 12 ins. and 24 ins. by 24 ins., various colours, 25s. sq. yd.
27 cwt. new Perspex sheets, paper covered, opaque colours, standard sizes, ⅛ in. to ⅛ in. at 5s. 6d. per lb.
8,000 pairs industrial canvas mittens, ex-Government stock, quick-release wrist fasteners, suitable gardening, heavy work, etc., 54s. gross pairs 125-24

Catalin Beads, ½-in. square, eight light pastel shades, also some transparent. Inquiries to Box 704, care of "Plastics." 125-6

Granulated P.V.C., ex-stock. Box 804, care of "Plastics." 125-2

Three tons virgin C-A moulding powder for sale, good colours, can be used in home market. Box 917, care of "Plastics." 125-18

Acetate sheets, transparent smoky, suitable for sun-glass discs, tennis or anti-glare visors, etc., 30/000 thick, approx. 4-cwt., 7s. per lb. Box 511, care of "Plastics." 125-20

Perspex acrylic sheet. Stockists offer good range in clear and coloured. Stock lists available. J. H. Berry (Plastics), Portland Works, Annesley Woodhouse, Notts. East Kirkby 2151. 127-2195

Perspex clear, paper covered, 36 ins. by 36 ins. by 3/16 in., 7/32 in. and ¼ in., for disposal. Write Box 515, care of "Plastics." 125-30

Plastic boards, 1/16 in., specially treated, highest artistic finish, suitable for panelling, furniture, bath, splash-backs, etc.; plain colours or marble effect, and wood (oak, mahogany, walnut, etc.), sheets 8 by 4 cut to requirements. Prompt deliveries. Larks Spraying Process, Monument Hill, Weybridge. 125-27

For sale constantly, cut-offs of ⅛ and 1/16-in. natural Holoplast, from 1s. per lb., according to size of pieces. Larks Spraying Process, Monument Hill, Weybridge. 125-26

Perspex sheets, coloured and clear, standard sizes or cut to your requirements, deliveries from stock, off-cuts also available. Write for stock list. Box 9762, care of "Plastics." 125-2200

Moulding powders. If you have any redundant stocks for disposal contact us and also give us your inquiries if you are in need of supplies of other powders. Box 9756, care of "Plastics." 125-2201

Metal powders and oxides. Quotations and samples on application. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-410

We are now able to supply an adhesive suitable for cementing the Perspex which we supply. Inquiries to Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. zzz-429

Raw Material Available and Wanted (contd.)

For sale, 15 tons P.V.C. black compound (recovered); samples available. Write to Cuprex, Ltd., Finsbury Pavement House, 120 Moorgate, London, E.C.2. zzz-428

Wanted, plastic waste and plastic piece goods. Send particulars, stating quantity and price. Box 6695, care of "Plastics." zzz-400

Perspex off-cuts, clear and coloured, cut to required size, lactoid rods and all forms of scrap plastic material; immediate delivery. Write, Plastic Department, J. E. Hoare, Byton Chambers, Amen Corner, S.W.17. zzz-399

Scrap. Why not let a well-established firm quote you for cellulose acetate, polystyrene, P.V.C. cuttings and other thermoplastic off-cuts and scrap? Having best use for these materials, highest prices can be paid. Quotations on receipt of representative samples to M. H. Grist (Plastics), Ltd., 82-84 Brighton Road, Surbiton, Surrey. Phone, Elmbridge 4214. zzz-395

SITUATIONS VACANT

None of the vacancies in these columns relates to a man between the ages of 18 and 50, inclusive, or a woman between the ages of 18 and 40, inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1947, or the vacancy is for employment excepted from the provisions of that Order.

Plastics Chemist. Vacancy exists in Birmingham for qualified Plastics Chemist in Development and Research Department. Primary duty to investigate application of Plastics to products of old-established company. Apply, stating age, qualifications, and salary required, to Box 9759, care of "Plastics." 125-2199

Wanted, first-class technical representative, fully conversant with and capable of estimating the cost of production of jigs, fixtures, press tools, plastics mould, etc., to keep medium-sized works in Coventry area fully supplied with orders. Good salary and prospects for real live man who can show results. Only men with exceptional contacts amongst buyers need apply. Box 514, care of "Plastics." 125-3001

Technician required for development work on moulded track carbon potentiometers. Applicants must have had several years' experience in the plastics moulding industry, and should possess a good general technical background, preferably with a knowledge of electronics. Post is in the Swindon area and carries good prospects of advancement. Age 25 to 35. Salary according to experience, in region of £500. Please write, giving full particulars to Box 503, care of "Plastics." 126-3002

Diesinker Engraver required by firm engaged on plastic mould work in Essex; person with experience is offered a permanent progressive and well-paid position. Send fullest details to Box 508, care of "Plastics." 127-3003

Wanted, laboratory extruder for plastic manufacture, approximately 1½-in. Box 966, care of "Plastics." 125-35

Leading company of plastic manufacturers has a vacancy for a technical manager. Applicants should have a university degree in mechanical engineering and must have had at least five years' experience in the large-scale production of high-quality compression and injection mouldings. Ability to control staff is an essential qualification. Successful applicant will be required to assume full responsibility for design of moulds, finishing jigs, fixtures, etc., the estimating of tool costs and guidance in the estimating of moulding costs. This is an unique opportunity for a man with initiative and ability to work closely with a team of enthusiasts.
The same company has a limited number of vacancies for progressive men under 25 years of age who desire to become associated with large-scale production and whose services are required in the tool design section. Young men who wish for greater scope within the industry would be well advised to consider this unique opportunity. Write, Box 965, care of "Plastics." 125-36

Toolmaker required. Experience on plastic mould work essential. Person with experience is offered a permanent, progressive and well-paid position. Send fullest details "Seaforth," Watchett Works, Oakhurst Road, Southend. 127-3045

Production Chemist required, fully experienced in Organic Chemistry, with expert knowledge of Calendering and Spreading of P.V.C. Experience in converting Rubber Spreaders an advantage, but not essential. Good opportunity for energetic and progressive man. State full qualifications and salary required for situation in S.E. Scotland. All applications will be treated in the strictest confidence. Box 812, care of "Plastics." 125-23

Situations Vacant (contd.)

Wanted for Plastic Moulding Management. A thoroughly practical man is urgently required to manage small works in Birmingham for production of household fittings in plastics. Ability to take full control essential, from buying raw materials and supervizing toolmaking to maintaining output in large quantities.
Suitable applicant for this post will receive good salary, output bonus and every incentive to make a success. Write fullest details in absolute confidence to: Box 836, care of "Plastics." 125-22

Insulation Engineer required for Electrical Manufacturers in Midlands for control during manufacture of insulating material processing and utilization for all classes of heavy electrical equipment. Permanent position. Applications stating age, experience and qualifications to Box 702, care of "Plastics." 125-21

Manager required for Plastics Dept. Should be familiar with the processing of thermo-plastic raw materials and in the production of Injection Moulding Powders. He must also be familiar with the purchase of raw materials and sale of the products, and have the necessary connections in the trade. Permanent position with good prospects and excellent income assured for the right person. Box 810, care of "Plastics." 125-37

Toolmaker. Thoroughly experienced man required for Press Tool and Mould work. One able to do all his own machining, in modern tool-room, to accurate limits; 20 years' tool-room experience minimum acceptable. Top rate paid, first-class working conditions in factory at Byfleet, Surrey. Write in first instance to Box 970, care of "Plastics." 125-34

Auto Setter required. Man with experience on B. and S. and Index Autos. Only those with minimum of 20 years' experience need apply. Highest wages and good conditions for suitable applicant at factory at Byfleet, Surrey. Write Box 969, care of "Plastics." 125-33

Tool-room Miller required in up-to-date tool-room. Thoroughly experienced man for bakelite moulds, die-casting moulds, able to generate auto cams and use jig borer. Must have at least 20 years' milling experience. Permanent progressive position for competent man with some mathematical knowledge. High salary, first-class working conditions in factory at Byfleet, Surrey. Write Box 968, care of "Plastics." 125-32

Tool draughtsman required with knowledge of layouts, tool estimating, and modern production methods. Only those holding higher National Certificate or equivalent need apply. High salary and good conditions in factory at Byfleet, Surrey. Write Box 967, care of "Plastics." 125-31

SITUATIONS WANTED

Ex-officer and pilot, 27, over year's unrivalled experience all departments of prominent plastics firm, now seeks progressive and remunerative post with similar firm. Box 811, care of "Plastics." 125-14

Young works manager requires position with good possibilities, good salary, hard work and long hours. Any offers. Box 638, care of "Plastics." 125-x215

TIME RECORDERS

Factory time recorders. Service rental. Phone, Hop 2239. Time Recorder Supply and Maintenance Co., 157-159 Borough High Street, S.E.1. 125-8459

WANTED

Manufacturers of Menthol Cones wish to buy plastic cases, bullet shape and domed shape. Offers, please, to Box 899, care of "Plastics." 386-16

MISCELLANEOUS

Extend Your Trade.
Use a Trade Mark. Consult
Trade Mark Protection Society,
12 Church Street, Liverpool. 130-9745

We supply within 24 hours Golderstat Photocopies, the inexpensive reproduction of documents, illustrations, photographs, etc. Golderstat, 54 Golders Gardens, London, N.W.11. Spe 5643. 126-659

Engraved name plates, scales, dials, etc., supplied. Tickets and Co., Box 2, Silver Street, Leicester. 129-9541

Huts. Nissen type, 36 ft. by 16 ft. and other sizes; also other industrial buildings suitable for workshops, canteens, site offices, clubs, etc. No licence required. Write, phone or call (open Saturday afternoons). J. Thorn and Sons, Ltd., Box 138, Brampton Road, Bexleyheath, Kent. Phone, Bexleyheath 305. zzz-430

Photography by Behr will show your product at its best. Ask for illustrated list. 44 Temple Fortune Lane, London, N.W.11. Speedwell 4295. zzz-436

Monomarks. Permanent London address. Letters redirected, 5s. p.a. Write, Monomarks, BCM/MONO76, W.C.1. 128-2192

Miscellaneous (contd.)

Acid containers. High-quality ebonite containers available from stock, 29 gallons capacity, dimensions 17¼ ins. by 13½ ins. by 39⅝ ins. high, suitable for handling and storing liquid chemicals, price £3 10s. each. United Ebonite and Lorival, Ltd., Little Lever, near Bolton, Lancs. 125-215

W. Page and Sons, Ltd.
Cartons, wooden cases, tea chests and other packing materials.
May we remind our many friends that the supply position with regard to packing materials of all kinds is a bad one, and is not likely to improve. By virtue of our progressive buying policy we are still able to offer large stocks of new and once-used cartons, tea chests and other packing materials, and invite your inquiries. New corrugated cartons made to your own specification from off-cuts, for which no Board licence is required. Your inquiries will receive our best attention.
The price of tea chests has now been advanced owing to higher cost of collection from the blenders. Large tea chests, 24 by 19 by 19, at 6s. 6d. each, all in perfect condition; small tea chests, 15½ by 15½ by 19½ and 18½ by 16½ by 16½, at 5s. 6d. each.
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Will you kindly note that as from October 18 we shall be opening our packing warehouse, which is equipped to deal with packing of all kinds, both for the home and export markets. We will receive the goods, pack them in cartons or wooden cases to your specification, and will despatch them in perfect condition to your customers. If this service appeals, we would be pleased to send our representative to discuss the details. We are in a position to supply materials and our experience in this field will save you money on packing costs and will certainly save space in your factory that could be turned over to increased production.
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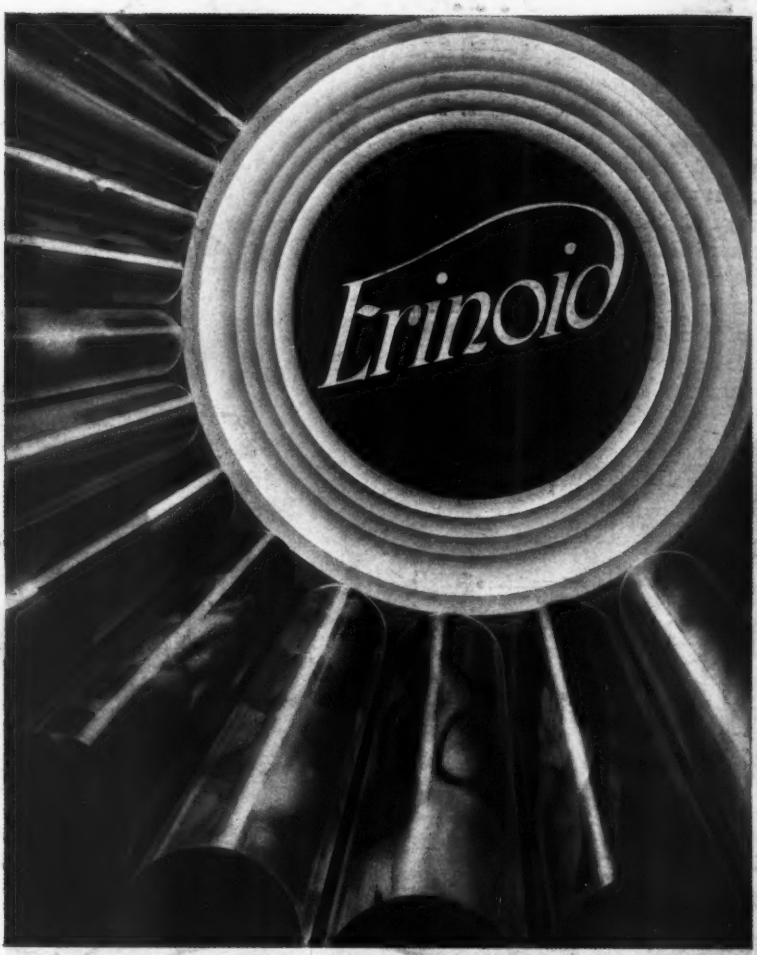

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